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LOLO, CROOKED FORK AND WHITE SANDS CREEKS HABITAT IMPROVEMENT

ANNUAL REPORT, 1983

BY

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Funded by

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ABSTRACT

In 1983 and under the auspices of the Northwest Power Act, the Clearwater National Forest and Bonneville Power Administration entered into an agreement to improve anadromous fish habitat in three major tributaries of the Clearwater River in Idaho. The Project was entitled "Lo10 Creek Habitat Improvement" (#83-522) and was funded at $55,927. Phase I (FY 83) habitat enhancement was initiated and completed on Lolo, Crooked Fork, and White Sand Creeks.

Enhancement of Lolo Creek involved the placement of 145 structures that were designed to alter the pool/riffle structure, increase diversity and cover, and purge in-stream sediment over 8.5 miles of stream length. Log weirs, organic debris, and boulder clusters were featured in the enhancement design. For the Lolo Project, the average unit cost was $186/structure. Spring chinook salmon was the primary target species and were observed utilizing the enhanced habitat in September.

Enhancement of the upper Lochsa River tributaries involved the placement of 263 structures of which 200 were felled riparian trees and 63 were anchored organic debris. Enhancement occurred over 9.1 miles of stream reaches and was designed to increase diversity, cover, and spawning habitat. Depressed stocks of spring chinook salmon and summer steelhead trout were the focal points of the enhancement. The average cost per structure equaled $9l/unit. Because of a mixed ownership pattern and in-channel variables, only 50 percent of the total stream distance was available for enhancement.

At Lolo, the overall project goal (# of structures) was exceeded by 51 percent. At Powell, we accomplished 66 percent of the enhancement goal.

In our opinion, the intent of the program and project objectives for Phase I have been met. Out-year projects (if funded) in these watersheds (FY 84-88) will complete the enhancement job.

INTRODUCTION

In 1983 and under the auspices of the Northwest Power Act, the Clearwater National Forest and the Bonneville Power Administration entered into a contractual agreement to improve anadromous fish habitat in three major tributaries of the Clearwater River in Idaho. The Project was entitled "Lo10 Creek Habitat Improvement" (#83-522) and its duration was scheduled from April 1, 1953 to January 31, 1984. The Project costs were not to exceed $55,927. The tributaries designated for enhancement were: Lo10 Creek, a tributary to the mainstem Clearwater River; White Sand and Crooked Fork Creeks, principal tributaries of the upper Lochsa River (Figures 1 and 2). Since the Project streams were located on two different Ranger Districts, the budget was allocated with 50 percent going to the Pierce District for Lo10 Creek and 50 percent to the Powell District for the Lochsa tributaries.

The following report is a description of the Project objectives, methodology, baseline conditions, activities, results, and conclusions. The report shall be stratified by the two Project Areas: Lo10 Creek and White Sand-Crooked Fork.

Project Objectives

Primary Project Objective

The primary objective was to partially mitigate the juvenile and adult anadromous fish losses accrued through hydroelectric development in the Columbia and Snake River systems by enhancing the spawning and rearing habitats of selected Clearwater River tributaries for spring chinook salmon and summer steelhead trout. The enhancement was designed to ameliorate the "limiting production factors- by the in-stream placement of habitat structures that would positively alter the pool-riffle structure and increase the quality of over-winter habitat.

Lo10 Creek Objectives

1. Enhance 40 to 60 acres of summer and winter rearing habitats.

2. Enhance the quality of 10 to 14 acres of spawning habitat.

3. Increase the utilization and productive capability of the habitat over a 12-mile reach.

4. Increase the diversity (number of niches) of the rearing habitat.

5. During low escapement periods, increase the seeding capability of the system by increasing the amount of hiding and escape cover for adult spawners.

6. Increase the smolt production capability of the habitat to a level that an annual increase of 4,000 steelhead and 10,000 salmon smolts is realized within two escapement cycles and sustained thereafter.

White Sand-Crooked Fork Objectives

1. Increase the quantity of spawning habitat by 20 percent over the long term.

2. Increase the amount of suitable resting, hiding, and escape cover for adult chinook salmon.

3. Increase the diversity (number of niches) of the rearing habitat.

4. During low escapement periods, increase the seeding capability of the system by enhancing the quality of the fry rearing habitat.

5. Enhance 60 to 75 acres of summer and winter rearing habitats.

6. Increase the smolt production capability of the habitat to a level that an annual increase of 21,000 steelhead and 36,000 salmon smolts is realized within three escapement cycles and sustained thereafter.

DESCRIPTION OF PROJECT AREA

The Clearwater National Forest (l-8 million acres) is located in north central Idaho and supports some of the most significant and valuable salmonid resources in the region (fig. 1). The Forest provides a total of 2,500 acres of spawning, rearing, and migratory habitats for two anadromous species - spring chinook salmon and summer steelhead trout. Of this total, LOO acres consist of high quality spawning habitat.

Recent history has documented the massive hydroelectric development of the Columbia and Snake Rivers and their major tributaries. This development has been costly in terms of the basin's and Forest's fish resources. In 1927, a dam built near Lewiston, Idaho virtually destroyed the run of spring chinook salmon in the Ciearwater River drainage. In the early 1970's, Dworshak Dam on the North Fork of the Clearwater River eliminated 60 percent of the Forest's highest quality habitat for steelhead trout; and Lower Granite Dam on the Snake river increased the mortality gauntlet to a total of eight dams on the system that fish destined for Idaho or the ocean had to negotiate, By the mid 1970's, Idaho stocks of anadromous fish had bottomed out and were perched on the brink of extinction. Since that time, accelerated efforts of mitigation and restoration have actuated a trend of significant recovery - especially for steelhead trout (fig. 3).

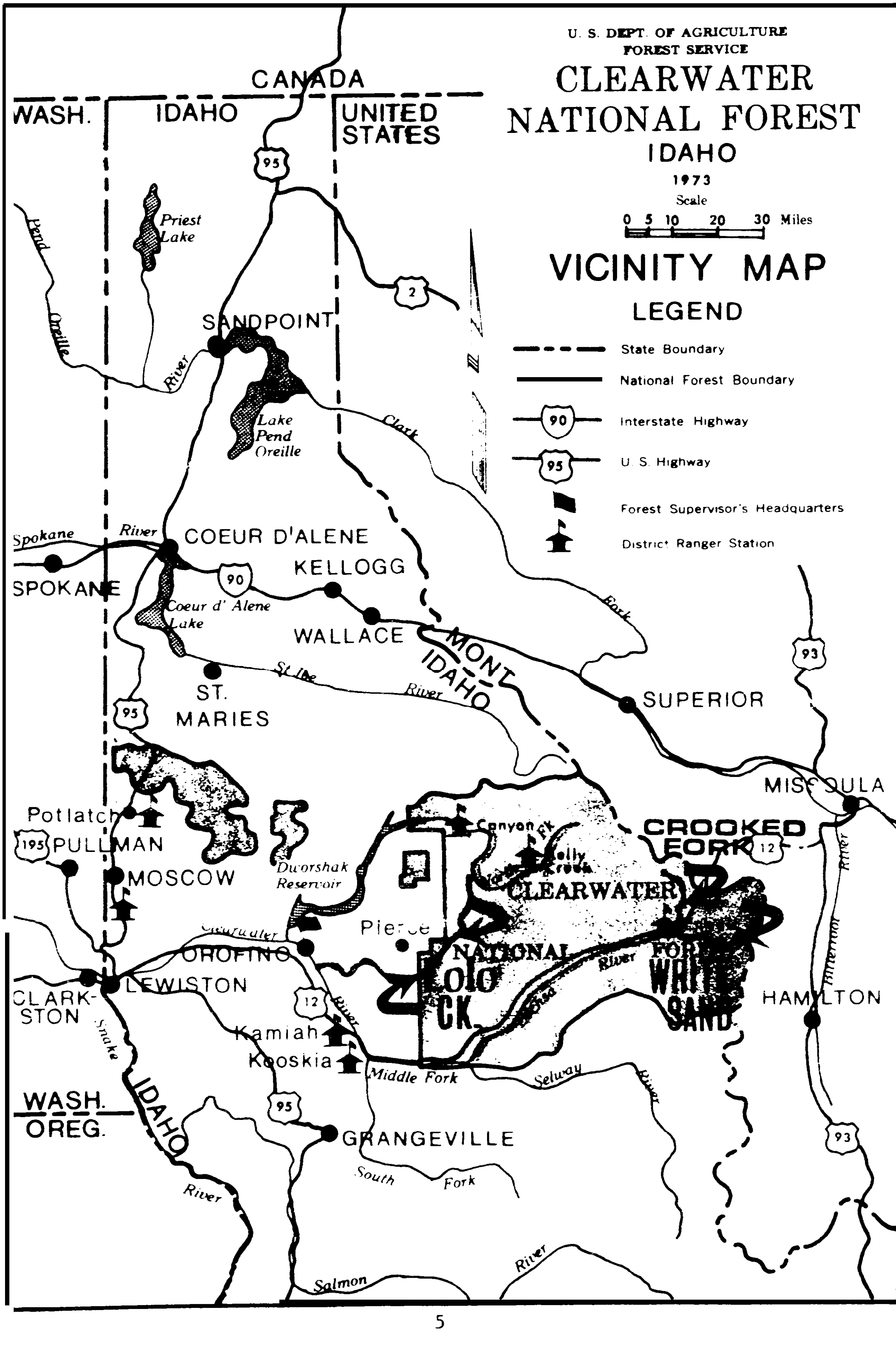
Three of the most significant producers of anadromous fish among the basin's tributaries are Lolo Crooked Fork, and White Sand Creeks. Lolo is the primary producer of salmon and steelhead for the lower Clearwater River. Crooked Fork and White Sand Creeks are the principal producers of the Lochsa River system (upper Clearwater River). Under optimum habitat and escapement conditions - Lolo, Crooked Fork, and White Sand Creeks are capable of producing 33 percent of the total steelhead and 44 percent of the total salmon smolt production on the Forest.

Lo10 Creek

Lo10 Creek, a seventh order stream, enters the mainstem of the Clearwater River from the north at river mile 54 and is 42 miles in length. The stream flows primarily in a south/south-westerly direction draining approximately **78 miles** of existing and potential anadronous fish streams. Of mainstem Lolo, 18 stream miles are within the National Forest boundary. The remaining 24 miles traverse a mixed ownership pattern of private, state, Nez Perce tribe, and the Bureau of Land Management interests. Major tributaries of Lo10 are Yakus, Eldorado, Yusselshell, Browns, and Yoosa Creeks (fig. 2). Lolo Creek drains a watershed of approximately 73,000 acres within the boundaries of the Forest. The stream has a range in elevation of 5 ,240 feet at its headwater sources near Hemlock Butte to 1,300 feet at its confluence with the mainstem Clearwater River. The range in elevation of the Project Area is 3,500 to 4,000 feet.

The Lo10 watershed is characterized by four major landtype associations or groups. These groups are: 1) old erosional surfaces shaped by fluvial processes; 2) deep creep colluvial lands that are transitional between cryoplanated uplands and the old land surfaces; 3) cryoplanated uplands characterized by broadly convex, frost-churned slopes; and 4) stream breaklands consisting of steep sideslopes radiating out to a broad basaltic plateaus. The Project Area consists primarily of the remnants of the old fluvial surfaces

FIGURE 1


U. S. DEPT. OF AGRICULTURE
FOREST SERVICE
CLEARWATER
NATIONAL FOREST
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1973
Scale
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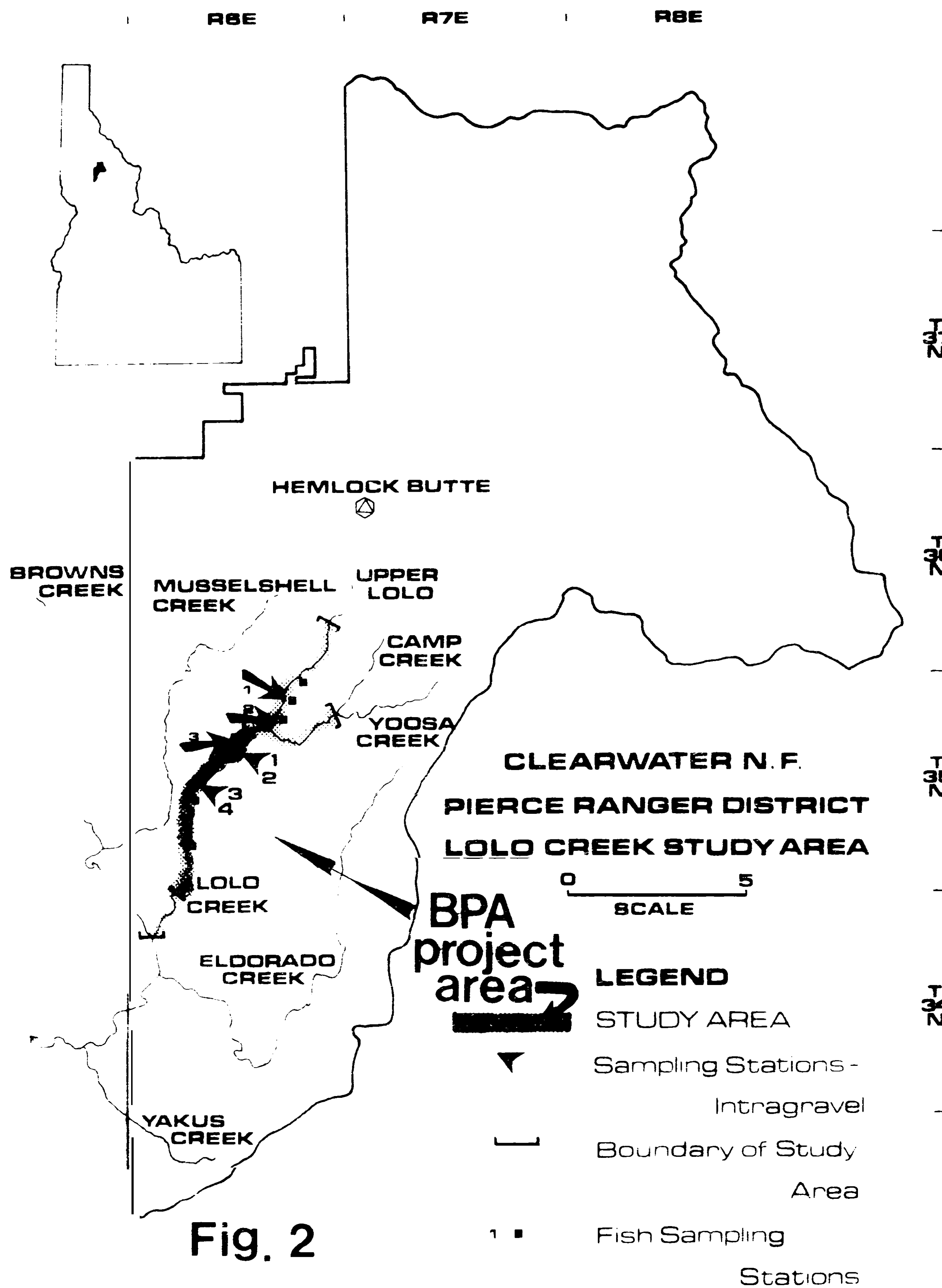
VICINITY MAP
LEGEND
State Boundary
National Forest Boundary
Interstate Highway
U. S. Highway
Forest Supervisor's Headquarters
District Ranger Station
CANADA
WASH.
IDAHO
UNITED STATES
Priest Lake
Pend Oreille River
SANDPOINT
Lake Pend Oreille
Clark Fork
Spokane River
SPOKANE
COEUR D'ALENE
KELLOGG
WALLACE
Coeur d' Alene Lake
ST. MARIES
St. Joe River
MONT.
IDAHO
SUPERIOR
MISSOULA
Potlatch
PULLMAN
MOSCOW
Dworshak Reservoir
Canyon
CROOKED FORK
CLEARWATER
NATIONAL
FOREST
Pierce
OROFINO
LEWISTON
CLARKSTON
HAMILTON
Kamiah
Kooskia
Middle Fork
Selway River
Bitterroot River
Snake
WASH.
OREG.
GRANGEVILLE
South Fork
River
Salmon River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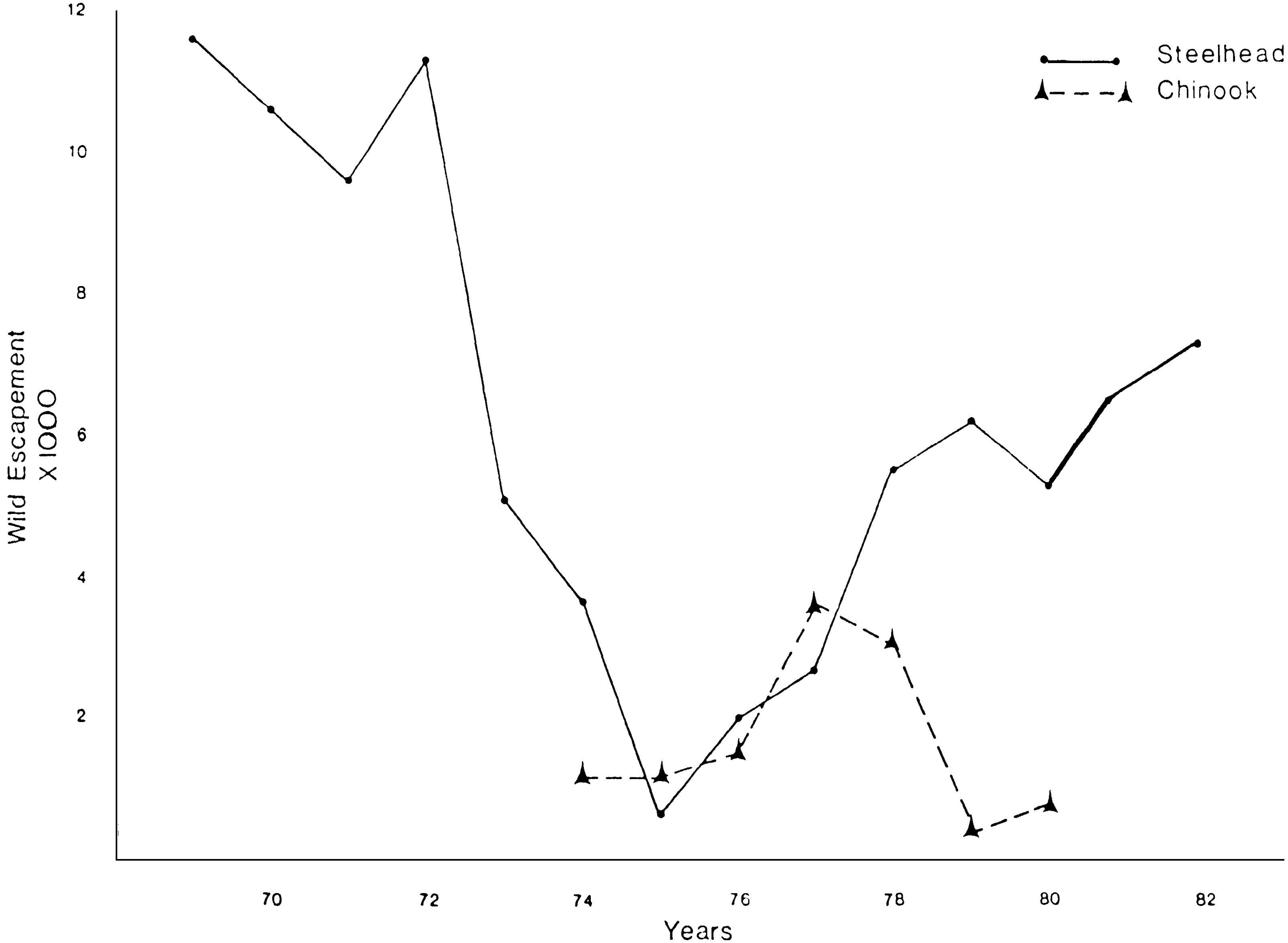
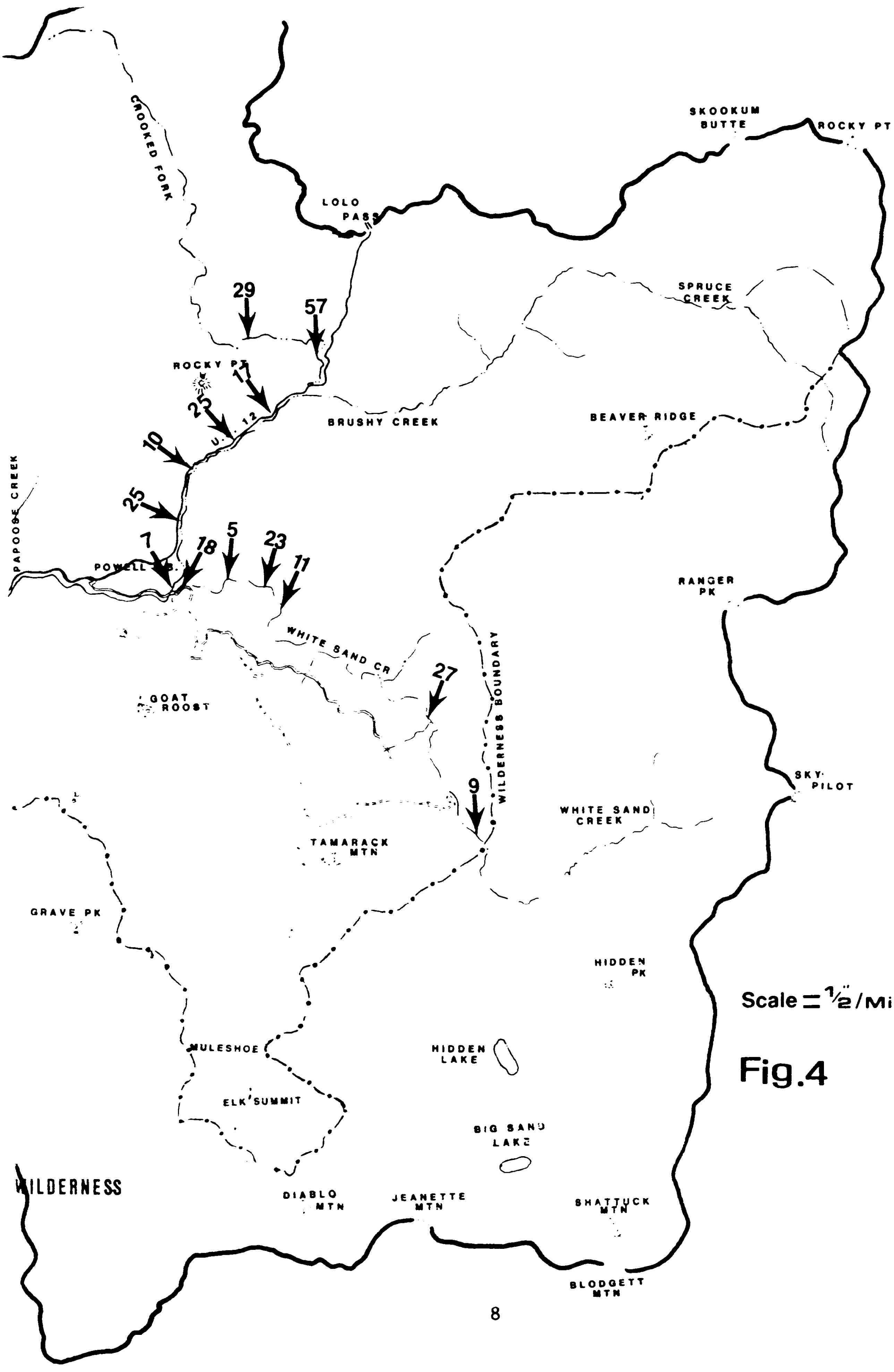
CAMP CREEK
YOOSA CREEK
LOLO CREEK
ELDORADO CREEK
YAKUS CREEK
CLEARWATER N.F.
PIERCE RANGER DISTRICT
LOLO CREEK STUDY AREA
0
5
SCALE
BPA project area
LEGEND
STUDY AREA
Sampling Stations - Intragravel
Boundary of Study Area
Fish Sampling Stations

Fig. 2

Figure 3

The estimated number of wild steelhead and chinook escaping to the upper Clearwater River and tributaries, 1969-1979 (from Pettit, 1980 and Lindland, 1980).





Scale = ½"/Mile

Fig.4

finely dissected by a dendritic drainage pattern. Lo10 Creek, as it flows through this landtype, is characterized by a low gradient (less than one percent), highly sinuous, broad channel exhibiting an alternating pool-riffle sequence and gravel-cobble substrate that produces good fish habitat. Dominant land and channel types are depicted in Figures 5 and 6.

Soils in the watershed are dominated by a silt-loam, loess cap over decomposed granitics. Both soil types are very erosive and partially account for the relatively high natural sediment levels of the channels. Because of the granitic nature of the soils, nutrient levels for good autotrophic production are lacking.

Predominant habitat types in the streamside zones of the Project Area are: grand fir/pachistima, western red cedar/pachistima, cedar/lady fern and subalpine fir/beargrass. Mixed stands of white pine, grand fir, western red cedar, Englemann spruce, and Douglas fir grow in the riparian areas adjacent to Lo10 Creek. Deciduous communities are dominated by willow/alder associations. Lo10 flows through several small. sedge meadows within the Project Area.

Lo10 Creek displays a rather wide amplitude in its seasonal flow regime ranging from an average of 500 c.f.s. during spring run-off to an average of 25 c.f.s.-during late summer, base flow. Instream flows are not appropriated by outside interests and are adequate for good salmonid production.

The Lolo watershed has a relatively long history (30 years) of timber management on the Forest. During this period, the allowable harvest has ranged from 15 to 30 million board feet. Road construction and riparian harvesting associated with this program have generated some adverse impacts on the Lo10 ecosystem. Excessive sedimentation, channel impingement, and elimination of large organic debris are the major impacts documented by Cspinosa (1975) during his baseline habitat survey. Most of the habitat degradation on Federal lands occurred during the 1950's and 1960's. Since that time, the habitat of Lo10 Creek has not suffered any major decline in quality (Espinosa, 1979 and 1983). Land management practices associated with timber harvesting have improved on the Federal portion of the Lolo watershed.

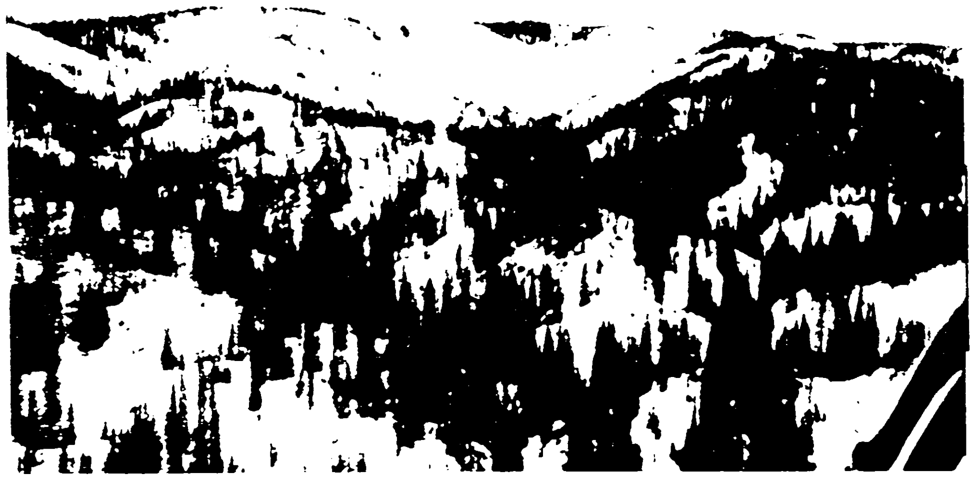
Some placer mining for gold does occur within the Project Area and has generated some deleterious effects. One operation near Siberia Creek is very small and has little potential for degrading habitat. The other is located near Winchester Point (stream mile 30.5) and is a substantial operation. The Forest Service administers the claim and is responsible for the management of surface resources such as fish habitat. Sediment impacts associated with the operation are minimized by the use of buffer strips, settling basins, and berms.

Over the past 10 years, the Clearwater National Forest has invested funds to mitigate and restore fish habitat quality degraded by land management activities. Fish passage barriers have been removed, riparian zones have been reforested, and chronic sediment sources have been stabilized. Since 1974, an annual program of habitat and population monitoring has been conducted within the Project Area. The sampling stations are displayed in Figure 2

In 1974, an intensive baseline habitat and population survey was conducted covering most of the Project Area (Espinosa, 1975). A summary of the most salient habitat parameters, measured over an 8.7 mile reach during late summer flows (35 stations), is provided below:

Figure 5. Typical landforms in the Lo10 Creek Watershed. Colluvial lands in foreground and cryoplanated uplands in background near Hemlock Butte.

Figure 6. Old erosional land surface shaped by fluvial processes. This is the dominant landtype group in the Lol Creek drainage. C-channel type in right foreground.



Channel Gradient	Stream Width	Stream Depth
1.5%*	34.1 feet	11.8 inches

Pool Quality	Bank Cover	Pool/Riffle Structure
72% of Optimum	60% of Optimum	23%:77% (1:3.4)

Cobble Imbeddedness	Dominant Substrate: Large Cobble (6-12")	Dominant Substrate: Small Cobble (3-6")
54%	23%	18%

Spawning Habitat

%Fines (less than 6.4mm)	Permeability
36%	5300 cm/hr.

* Mean values.

A review of this data reveals that habitat factors potentially limiting to fish production in Lo10 Creek are: suboptimum pool/riffle structure, suboptimum pool quality, lack of diversity (low bank cover and in-stream organic debris), and excessive sedimentation in both spawning and rearing habitats.

Population sampling during the period from 1975 to 1979 reveals a fish community structure dominated by steelhead trout (71% composition) and to a much lesser degree, chinook salmon (21% composition). Juvenile fish densities (all age classes for steelhead and age 0+ for chinook) during late summer of the same period averaged 67 fish/LOO square meters (m2) for steelhead and 33 fish/l00m2 for chinook salmon (Espinosa and Branch, 1980). Both species have been periodically and extensively stocked in the system with excess hatchery fish. Because of this, determination of pre-treatment smolt carrying capacity for Lo10 Creek will be difficult.

Based on some relationships developed by Espinosa (1983), it is likely that under optimum escapement levels, (Lolo's winter holding capacity (most limiting)) for steelhead age l+ (smolt indicator) approximates 7 fish/l00m2 and for chinook 0+, it might range from 14 to 20 fish/lOOm2.

Upper Lochsa

Crooked Fork and White Sand Creeks reach confluence near Powell, Idaho (3500 feet elevation) to form the Lochsa River (Figures 1 and 4). Both streams are in fact small rivers with each draining approximately 150,000 acres of the Bitterroot Mountains and coursing some 24 miles to their merger.

Both streams are characterized by a flow regime of wide amplitude. Crooked Fork displays a mean discharge of 3000 c.f.s. during the peak run-off period and 160 c.f.s. during the late summer, base flow; whereas, White Sand exhibits an average flow of 3000 c.f.s. during peak run-off and 170 c.f.s. at base flows. Within the project area, Crooked Fork shows a mean stream width and depth of 84 feet and 1.1 feet respectively (base flows); while White Sand displays a mean width and depth of 86 feet and 0.8 feet. Both systems are characterized by similar channel gradients with a mean of 1.0 percent and a range of 0.5 percent to 2 percent.

The Project streams drain a variety of landforms that include glacial, valley trains, steep breaklands, colluvial drift slopes, and alluvial flood plains. Breaklands and alluvial plains dominate their watersheds. Granitic soils of the Idaho Batholith typify the geology of the area. The streams flow through dense, mixed coniferous stands of western red cedar, Douglas fir, Englemann spruce, white pine, ponderosa pine, and larch. Few deciduous species are present within the riparian zones.

Crooked Fork has experienced extensive timber harvesting and road construction for the past two decades. Most of this activity has been concentrated in its lower reaches and in the Brushy Fork subdrainage. Impacts associated with sedimentation and over-harvesting in the riparian zones have been moderate. The upper reaches of Crooked Fork are undeveloped and pristine. White Sand Creek has only been developed in its extreme lower reaches from Beaver Creek on downstream. Its Beaver Creek tributary has been extensively harvested and roaded. Impacts to White Sand Creek have been minimal, and it is essentially roadless and pristine.

Both watersheds are under the management of mixed ownership; the U.S. Forest Service and Plum Creek Timber Company. Crooked Fork is characterized by a checkerboard pattern with Plum Creek owning some 34,000 acres (23%). The Forest Service administers 98 percent of the White Sand watershed.

The headwaters of both drainages are located in either a wilderness candidate area (Crooked Fork, RARE II) or a designated wilderness (White Sand, Selway-Bitterroot Wilderness).

In 1979, an intensive habitat survey was completed on Crooked Fork Creek by Powell District personnel. A summary of the most significant habitat factors, measured over a 12-mile reach (48 stations) encompassing the Project Area is presented below:

Pool Quality	Bank Cover
53% of optimum*	70% of optimum
Pool/Riffle Structure	Cobble Tmbeddedness
36%/64% (1:1.8)	Less than 25%

Dominant Substrate

Boulder (Greater than 12")	Large Cobble (6-12")	Small Cobble (3-6")
28%	26%	22%

Spawning Habitat

12,000 square yards

(30%, 2,400 square yards for chinook salmon)

* Mean values

A review of this data suggests that habitat factors potentially limiting to fish production in Crooked Fork are: suboptimum levels of pool quality, bank cover, pool/riffle structure, and diversity. Moreover, the amount of suitable spawning habitat for chinook salmon may be limiting.

Population monitoring of the system during the period from 1975 to 1980 indicates that Crooked Fork's mean smolt production level for steelhead was only 6 percent of biological potential. Extremely low escapement has been the problem. During the last few years, increased escapement has tripled the production of steelhead smolts.

Likewise, the production of chinook smolts has, during the same period, equalled only 26 percent of biological potential despite periodic stocking of hatchery fish. Chinook escapement to headwater tributaries such as Crooked Fork has remained low in recent years (15-20% of full seeding potential).

The most recent habitat survey of white Sand Creek was conducted by Forest Service personnel in 1971. A synopsis of that survey is provided for the 13-mile reach of the Project Area:

Pool Quality	Pool/Riffle Structure
25% of optimum*	25%/75% (1:3)
Bank Cover	**Spawning Habitat**
75% of optimum	200 square yards below wilderness boundary. 67,000 square yards within wilderness, but outside Project Area.

* Mean values

It is possible that suboptimal pool quality, pool/riffle structure, bank cover, and diversity may be habitat features limiting the production of anadromous fish from White Sand Creek. Although spawning habitat is lacking within the Project Area, ample habitat suitable for salmon and steelhead spawning is located within the Selway-Bitterroot Wilderness.

As with Crooked Fork, adult escapement of salmon and steelhead to White Sand has been very low during the last 8 years. In 1983, the late summer density of age l+ steelhead equalled 13 percent of biological potential. Similarly, the summer density of juvenile chinook (0+) was only 3 percent of biological potential over the period from 1975-1980. In 1983, the density of juvenile chinook in the upper transects was 1 percent of biological potential.

METHODS AND MATERIALS

Lolo Creek

Diagnosis of the ecological situation in Lo10 Creek indicated that four interrelated habitat factors might be limiting the system's inherent capability to produce fish. These factors are operative within the spawning, summer and winter rearing habitats and are described as: 1) sub-optimal pool/riffle structure, 2) sub-optimal pool quality, 3) a lack of diversity, and 4) excessive instream deposition of fine sediments. All of these factors are responsive to the habitat enhancement technique of instream placement of structures. Of the four factors, changing the pool/riffle structure to the more "classical", optimum level of 50:50 was the primary effect we were trying to achieve. This alteration would increase the number of summer and winter rearing units which in turn would increase the smolt productive capability. Associated with this quantitative objective was the effort to increase the quality of the system's pools - both existing and man-made. Therefore, we selected several pool- forming structures that would achieve both objectives and had a proven "track record." These structures are: log weirs, "K"-dams, boulders, and organic debris (Reeves and Roelofs, 1982).

In order to create some diversity (increase the number of niches, "the edge effect-), we used several types of large organic debris plus boulders. For debris, we utilized existing instream logs and cedar stumps plus directionally felled streamside conifers. Boulders were selected to create "pocket water" pools and were also used in combination with debris within reaches characterized by a mono-typic habitat profile.

The pools and riffles of Lolo contain excessive amounts of sediment less than 6.4mm sieve size. This sediment reduces emergent fry survival via entrapment and lowers intragravel permeability and dissolved oxygen. It also reduces winter habitat survival by filling-in pools and interstitial cobble space. Log weirs will channel and direct flows so that the gravel "tail-outs" (spawning sites) of the pools are purged of sediment. Large organic debris was the primary structural device used to reduce sediment levels. By arranging the debris to function as deflectors and by felling riparian trees at the proper angles, we were able to alter the channel's hydraulics enough to entrain fine sediments.

Boulder clusters, arranged in diamond and triangular configurations, also cleansed cobble and gravel substrates.

The design of the project was such that the structures and their effects would compliment each other. Moreover, these specific structures were selected because of their capability to achieve manifold enhancement effects. For example, log weirs created pool habitats both upstream and downstream from the site, purged sediment from the "tail-outs", and added diversity to the habitat structure. Frequently, boulders and organic debris were placed at the same site in order to assist with sediment-cleansing and diversity. Within a single, 0.25 mile reach-- log weirs, debris, boulders, stumps, deflectors, and felled riparian trees might be used in combination to enhance specific spawning and rearing habitats unique to that reach.

Upper Lochsa

The situation for the Upper Lochsa tributaries predicated the use of only one type of habitat structure-- large (>24 inch diameter breast height (d.b.h.)) organic debris. Because of each system's size and peak flow regime, it is not posible (or practical) to hold instream structures such as "K"-dams. Preproject field surveys indicated that natural deposits of organic debris were enhancing the habitat and populations by creating diversity and hiding cover for emergent fry, scouring pools for the larger juveniles, enhancing pool quality by adding cover, and by retaining gravels suitable for spawning. Because of past natural fire and silvicultural histories, riparian stands were not providing sufficient debris input to the ecosystems. Consequently, the habitat quantity and quality that the debris created became limiting. Therefore, the project design involved the selection of streamside conifers of the proper size (>24" d.b.h.), species (western red cedar, Englemann spruce, and Douglas-fir were preferred), and location so that when directionally felled and secured with cable, they would create the desired habitat effects plus withstand the stream's hydraulics. Forest Service reaches of both streams lacking debris, diversity, and spawning habitat were selected for enhancement. Backwater side channels, because of their smaller size and lower flows, were identified as highly preferred enhancement sites. Felling of conifers adjacent to these channels was concentrated.

Pre-implementation Phase

In mid-June and after high water, a field layout on Lolo Creek was conducted by Project Biologists. At Powell, it was mid-July before flows lessened sufficiently to permit initial field activities. To assist with this activity, a set of specific channel and habitat criteria was established to guide field identification of reaches and sites suitable for specific types of habitat structures (see Appendix A). The criteria were based upon a knowledge of factors limiting the Project streams plus upon the principles of hydrology, channel morphology, and habitat enhancement.

For both Project Areas, specific reaches were identified first and then established on field maps. For example, a reach displaying the following characteristics was established as suitable for boulder clusters: 1) substrate of small and large rubble, 2) areas lacking "pocket water", pools, and diversity, 3) nonspawning areas (crests of riffles), 4) "B" channel reaches of higher gradient and velocity, and 5) habitat types of extensive shallow riffles and runs. Similarly, reaches for log weirs, deflectors, and anchored debris were identified. Because of checkerboard, mixed ownership on Crooked Fork and White Sand Creeks, it was necessary to identify and mark ownership boundaries as part of the field layout. Once enhancement reaches were established sites for individual structures were marked within the reach. Figures 7-10 display this process. Photographs were taken of the reaches and sites to establish a "before project" baseline. A representative example of the "before" conditions for both Project Areas is presented in Figures 11-22. As part of the layout, access and egress point6 for the heavy equipment were marked. In addition, sources for structural materials were identified and marked-i.e. boulders, debris, weir logs and riparian trees. At Lolo, we were fortunate in having ample sources within the Project Area.

The conclusion of the preimplementation field layout involved orientation and training of the Project crews. At Lolo and Powell, we had two, three-man crews

Figure 7. Pre-implementation phase of project. Marking riparian trees for organic debris reaches. Western red cedar was a preferred species (Lo10 Creek).

Figure 8. Lay-out phase: identifying and marking large “opportunity” debris and logs for weir and debris structures (Lo10 Creek).

Figure 9. Lay-out phase: A project site marker identifying the stream reach, type, and site of habitat enhancement (Lo10 Creek).

Figure 10. lay-out phase: marking a large cedar stump, and root wad for an anchored debris site in Lolo Creek.

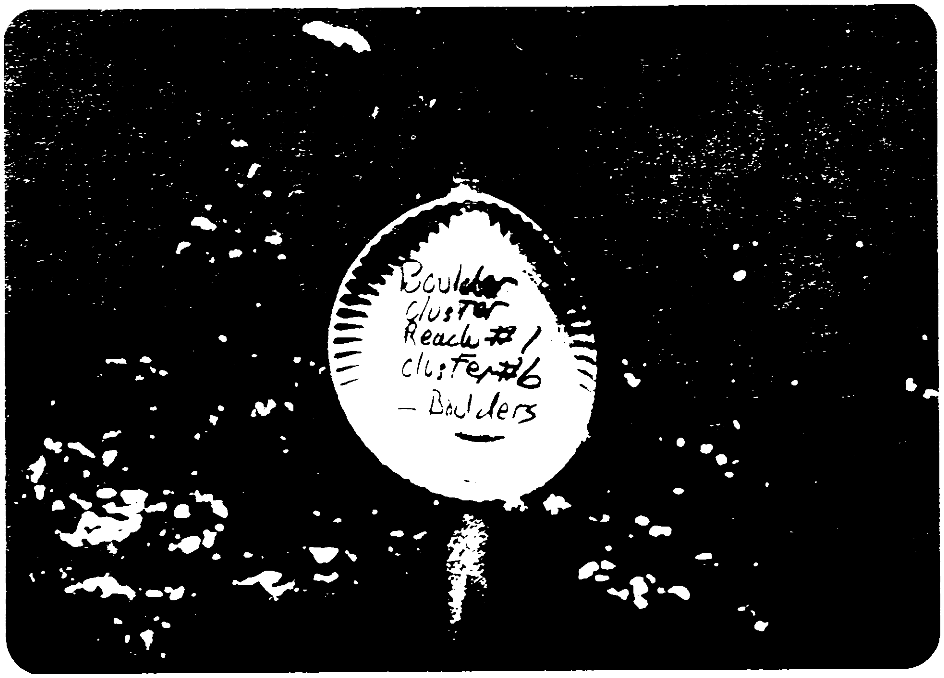

Boulder
cluster
Reach #1
cluster #6
– Boulders

Figure 11. Typical baseline conditions in Crooked Fork Creek (Powell) in the reach above the Highway 12 bridge. Debris collections are natural.

Figure 12. Baseline conditions in White Sand Creek (Powell) near Colt Creek Cabin. Habitat characterized by deep runs, pocket water pools, large substrate, and minimal organic debris.

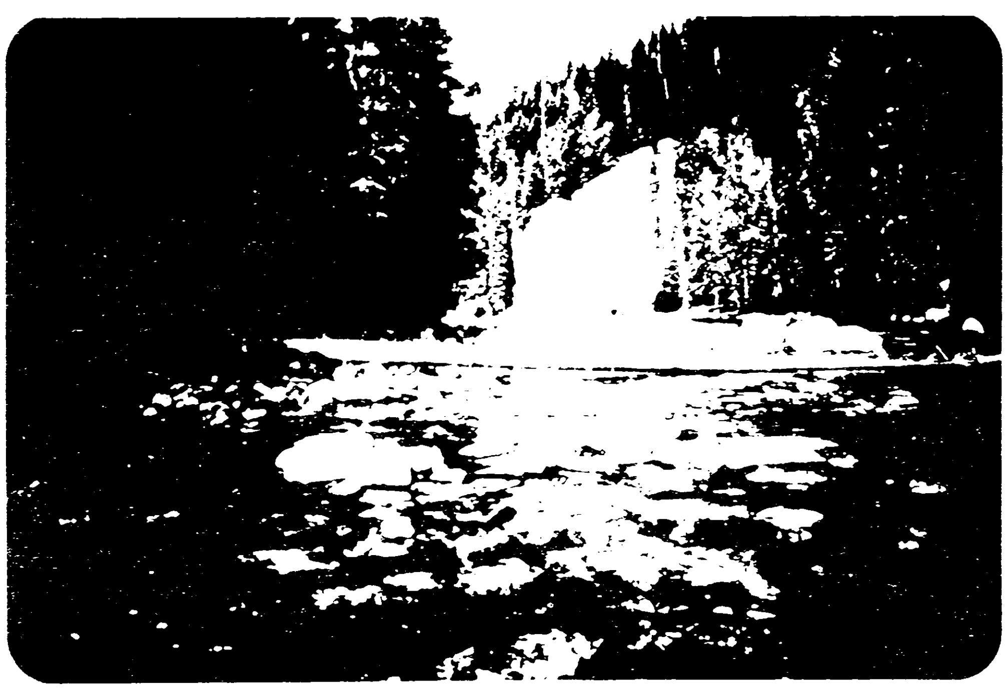


Figure 13. Baseline conditions in Lolo Creek. This is boulder cluster reach #1 (upper segment) prior to enhancement. Habitat dominated by shallow runs and riffles.

Figure 14. Downstream aspect of boulder cluster reach #1.

Figure 15. Boulder cluster reach #2 in Lo10 Creek prior to enhancement. Notice the lack of diversity. Habitat dominated by shallow runs.

Figure 16. Anchored debris reach #1 in Lo10 Creek. Notice the lack of diversity and cover for spawners.

Figure 19. Pre-project condition of AD-reach #3 (Lo10 Creek).

Figure 20. Pre-project profile of AD-reach #4. Habitat typified by shallow runs, low pool frequency and quality, lack of cover and diversity.

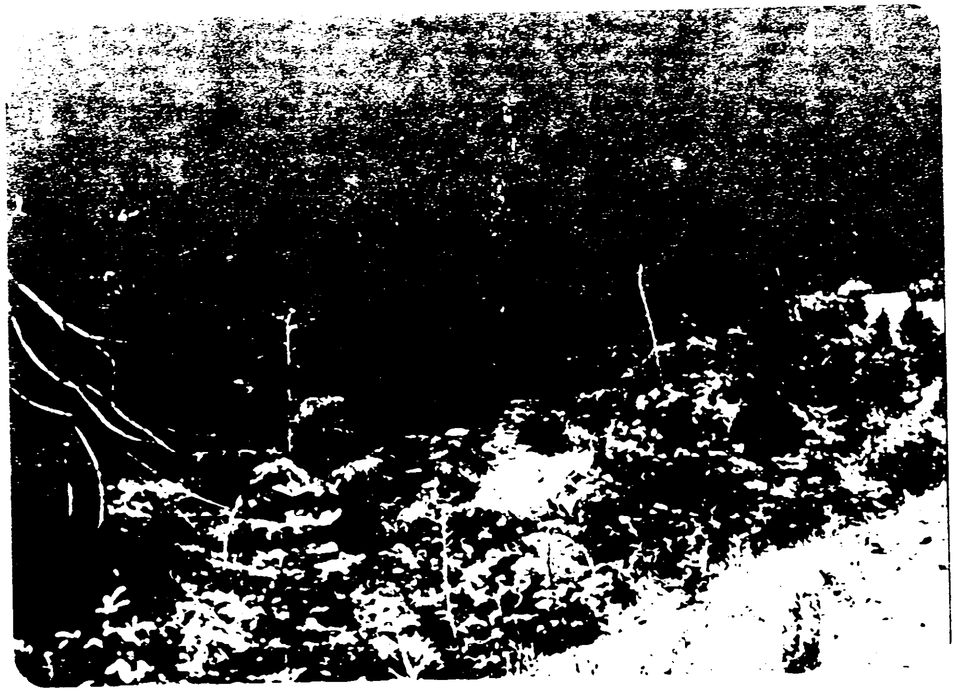


Figure 21. Baseline profile of AD-reach #4. - mid-reach perspective. This reach was later modified with a diversity of structures.

Figure 22. Baseline profile of log weir reach #1 - a critical spawning reach for spring chinook salmon in Lo10 Creek. Notice the lack of hiding and holding habitat for spawners. The tracked backhoe is being "walked" into position.

with expertise in hydrology and fisheries biology. At Powell, two Forest Service sawyers were contracted in addtion to the 3-33:: crew. Crew leaders were experienced in field work involving habitat enhancement. District biologists provided additional direction, leadership, and "hands-on" assistance.

Implementation Phase

On July 12, the Lolo project was implemented as the crew procured logs for weirs and boulders for the reaches. The crew felled trees from nearby stands and had them skidded with an Idaho jammer to collection points. They were then hauled to individual sites via log truck (Figures 23-24). Boulders were excavated from cuts and 'ills along the No. 103 road which parallels Lo10 Creek. Excavation was accomplished with a #966 Case front-end loader and a small #580-C Case backhoe. Minimum size on the boulders was 2 to 3 feet (0.8m) in diameter, boulders up to 5 feet (1.5m) in diameter were acceptable. Boulders were hauled to preidentified sites with a 5 yard (3) dump truck.

Logs for weirs and "K"-dams were selected from a variety of conifers: Douglas fir, western red cedar, Englemann spruce, and western white pine. Log diameters ranged in size from 15 to 30 inches and averaged 20 inches. Size was selected to fit specific channel conditions such as width, depth, gradient, and proximity to spawning areas. For example, a shallow site (<0.5 foot) of low gradient (<1%) with spawning gravels within 100 feet would require a 15-inch log. This would provide adequate pool formation and prevent upstream flooding of critical spawning areas. Where feasible, the largest diameter log was selected to prevent displacement during peak flows. Logs were cut to fit a minimum distance of 10 feet into each bank. Often they were cut to fit 12-15 feet into the bank. Bank trenches for weirs and dams were excavated by a Link Belt 84500 crawler backhoe equipped with a 36 inch, yard (3) bucket with "thumb" attachment (Figures 25-28).

The backhoe also prepared a trench for the log in the stream bottom by using a side by side sweeping motion with the bucket. The sill log was then placed in the trench by the Link Belt (Figure 29). Pressure was then applied to the top of the log height above the stream to ensure even flow over the log. Following this, the ends were secured by the placement of large (3 to 4 feet in diameter) boulders on the up-and-downstream faces of the log (Figures 27-28). Stream cobble and sediments were used to backfill the trenches. At this point, a center notch or multiple notches were cut into the log, width of notch varied from 2 feet to 12 feet with an average of 5 feet. Depth of the notch varied from 2 inches to 6 inches with an average of 4 inches (Figures 30-32). Hogwire (2x2 inch mesh, 16 gauge), 6 feet in width with welded joints, was double-row stapled to the upstream face. Only one width per log was used. At this time, the Link Belt backfilled the upstream face with material excavated immediately downstream from the weir (Figures 33-34). This provided an early start to pool formation. Some weirs were "rocked-in" by the crew.

"K"-dams were constructed in much the same manner as log weirs. Because of their complexity and expense of construction, only a few were constructed. They were used to provide a comparison with single log weirs and at sites requiring extra strength and stability as afforded by the side-wings (lateral log supports). The major difference between the dams and weirs is the addition of side-wings and mud sills. These structures can lend badly needed support and strength where bank stability is lacking. Three different types of "K"-dams were constructed: those with a single wing on the downstream side, those with dual wings on the upstream

Figure 23. Implementation phase: felling riparian conifers in the upper reaches of Lo10 Creek (AD - #l).

Figure 24. Implementation (Lolo): loading and hauling of sill logs for weir structures. Nearby sources were readily available and helped to reduce logistical costs.

Figure 25. Implementation (Lolo): "K"-dam construction. Setting the wing structures in place with the 36" bucket equipped with tongs. Notice the wing trenches and length (15 feet) of log.

Figure 26. Project work (Lolo): Constructing the wing unit of a "K"-dam. Notice the amount of excavation necessary for this supporting structure. "K"-dams required 2-3 days for construction.

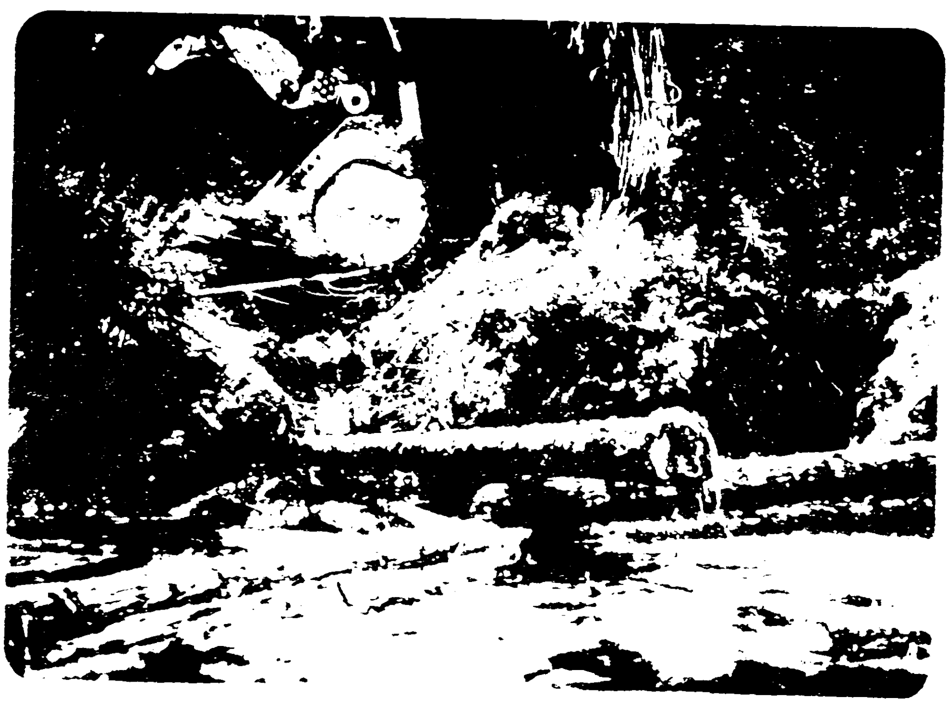


Figure 27. Project work (Lolo): Link-belt (LS-84500) tracked backhoe constructing a log weir structure. Large boulders were placed on the up-and-downstream faces of the sill log at its juncture with the channel bank.

Figure 28. Project work (Lolo): log weir construction. Stabilizing the ends of the sill log.

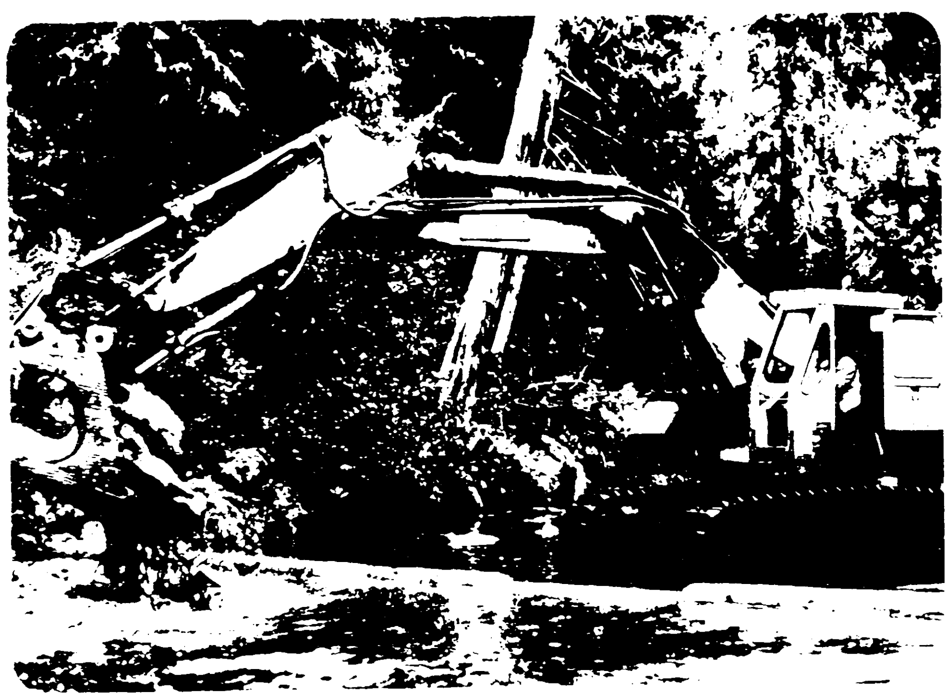


Figure 29. Project work (Lolo): log weir construction; securing and placing the sill log.

Figure 30. Project work (Lolo): completed, double-notch log weir near the critical salmon spawning reach. Notice the cleansing, sorting action at the "tail-out" of the pool.

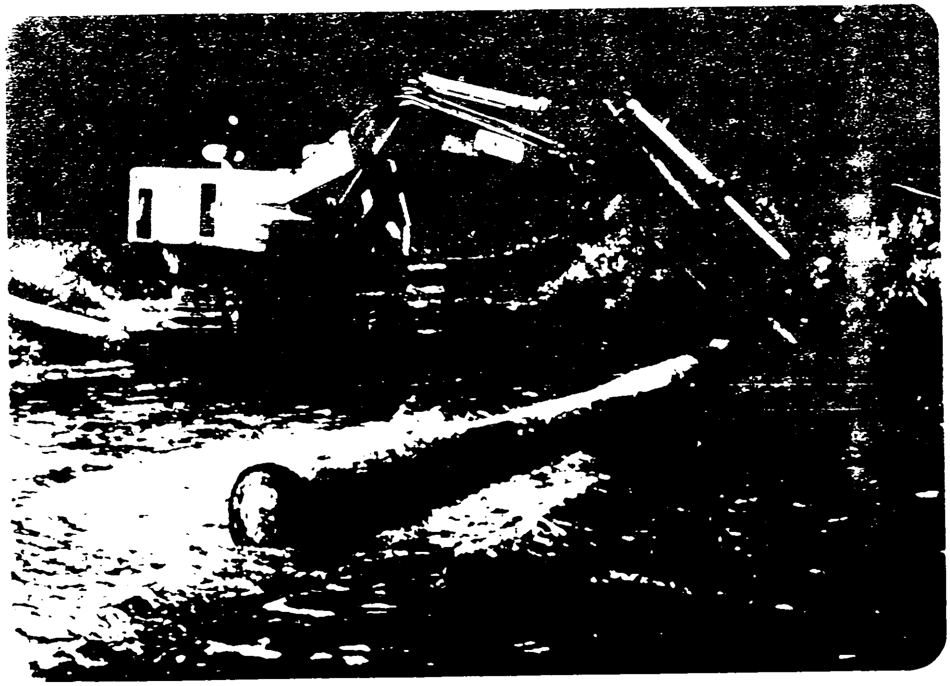


Figure 31. Project work (Lolo): completed, wide-notch log weir in upper Lolo. Notice the large, stabilizing boulders at the end of the sill log. Bank disturbance associated with single weir construction is minimal when compared to that of "K"-dams.

Figure 32. Project work (Lolo): "K"-dam construction showing medium size notch, completed wing assembly, and sill log trench.

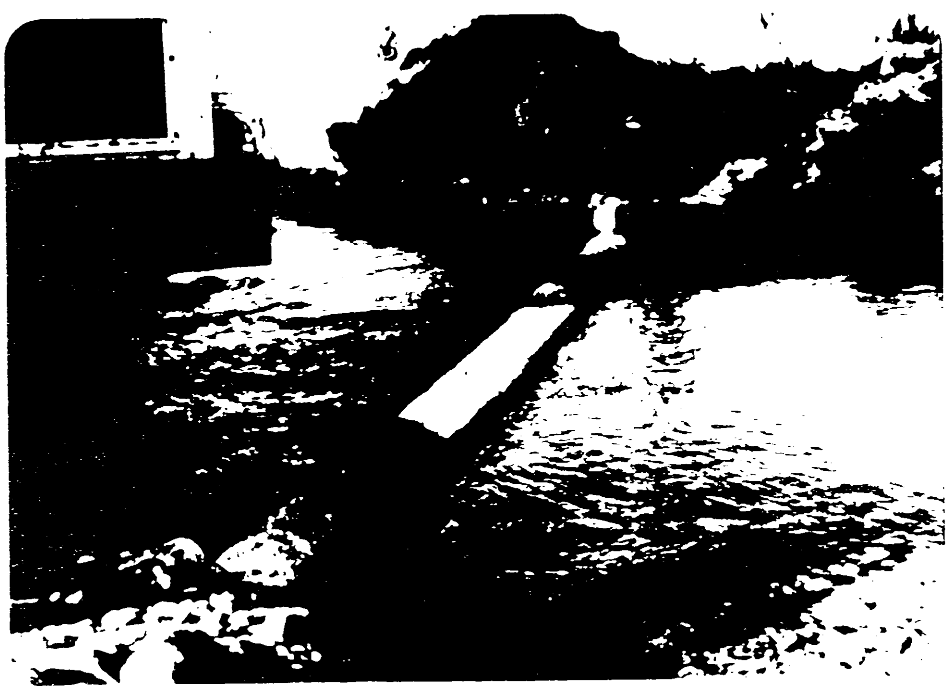


Figure 33. Project work (Lolo): backfilling upstream face of "K"-dam.

Figure 34. Project work (Lolo): backfilling process with tracked backhoe. "K"-dam is located 0.5 mile upstream of section 6 bridge.

side, and those with the classical four wing structure (Figures 35-38). Single wing structures were constructed where one of the two banks was shallow (gradually sloping). Wing trenches were excavated after placement of the main sill log and extended into the banks 12 to 15 feet. After cutting the logs to proper length and lowering them close to the sill log (with tongs), a correct angle was sawed to fit the main log, and then the wing log was set in place. Each wing consisted of two logs of 15-20 inch diameter. The logs were pinned together with l/2 inch (diameter) rebar, 24 inches long and with one end sharpened. A l/2 inch (diameter) brace and bit was used to drill starter holes. A five-pound maul was used to drive the drift pins. Four mud sills were used on each dam, they were made from four-inch diameter cedar poles. The sills were evenly spaced across the channel on the upstream face and secured with staples. The sills were a minimum of eight feet long. A minimum of 16 boulders was used *to* secure the four-wing dam. Stream cobble, gravel, and sediments from the downstream side were used to fill in the remainder of the cribs and the upstream side of the dam (Figures 35-38).

Most of the deflectors we placed were categorized as "opportunity" logs (or debris), that is, they were down logs near the stream channel that were skidded close to the enhancement site by the Link Belt and then utilizing the bucket's "thumb" attachment, placed into position (Figures 39-40). Deflectors were positioned with no more than l/3 of the log in the channel and at angles ranging from 10 degrees to 45 degrees in order to provide stability. As a precaution against displacement, all deflectors were secured to standing green trees with 5/16 inch cable and clamps.

Once secured, the threads on the cable clamps were destroyed to prevent vandalism. To prevent slippage of the cable, a 360 degree notch (2 inch wide x 2 inch deep) was cut into the log and the cable secured there. A variation of the "opportunity" deflector was the lateral log deflector. Trenches were excavated 15-20 feet into the bank at an angle of 30 degrees, two logs cut to length and placed upon each other in the trench. The logs were pinned together and protruded into the stream approximately 15-20 feet. Logs were secured with boulders as previously described.

Organic debris consisted of felled riparian conifers and cedar root wads (stumps with root networks). Trees were selected to be directionally felled at moderate angles 10 degrees to 25 degrees, and with at least l/3 to l/2 of their length on the bank. These considerations provide protection against displacement during peak flows. Additionally, the trees and stumps were notched and cabled in the manner described previously. Branches not in the water were trimmed for aesthetics. Although we selected a variety of species, cedar was the preferred conifer. Size varied from 20 to 30 inches d.b.h. At some sites, secured trees were cabled together to function as *a* cluster. In some reaches, anchored debris was arranged in an alternating sequence from bank to opposite bank (Figures 41-44).

Because of the extensive salvage logging of cedar products along Lolo, many large (up to 120 inches diam.) stump-root wads were available for use. These root wads functioned as deflectors and overhead cover devices. In addition, the "finger-like" projections of their root systems provided extensive cover for juvenile fish. Root wads were placed into position with the backhoe and cabled to green trees on the bank (Figures 45-46).

Figure 35. Project work (Lolo): "Fish Crew" stapling "hog" wire to sill log and mud sills of "K"-dams.

Figure 36. Project work (Lolo): crew member pinning wing assembly to base log of "K"-dam.

Figure 37. Lo10 project: completed side wing (single) on modified "K"-dam. Single side supports were used in areas where stable channel banks were lacking.

Figure 38. Lo10 project: completed wing assembly on "full-blown" "K"-dam.

Figure 39. Lolo project: securing and placing large "opportunity" debris with root mass at the head of an existing pool. This site is in log weir reach #1.

Figure 40. Lolo project: placement of the structure at the designated site. This structure will provide cover and function as a scouring device.

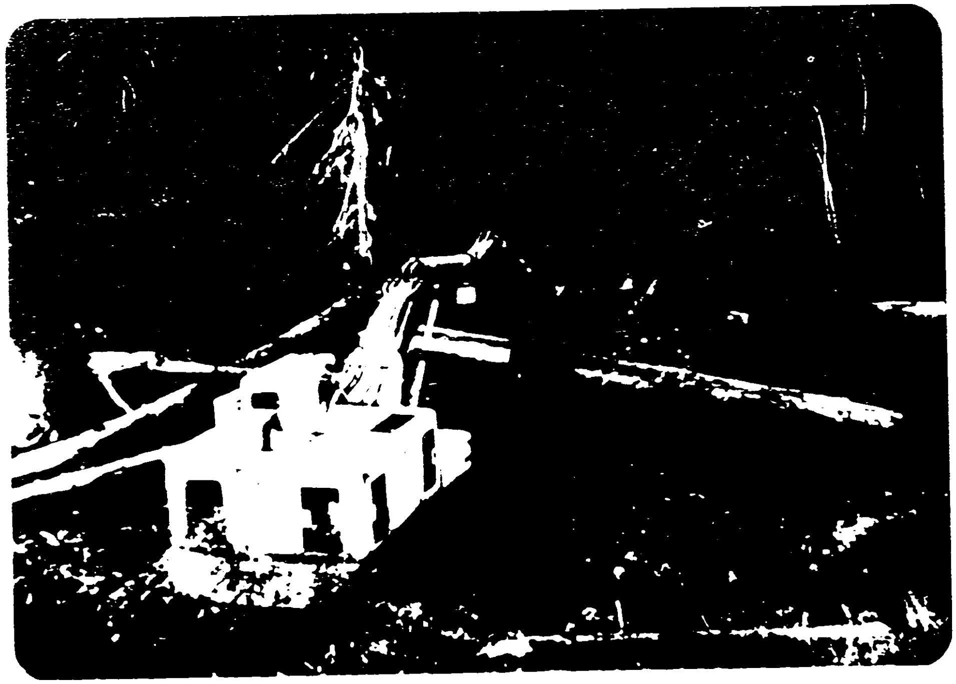


Figure 41. Lolo project: anchored debris reach #2; felled riparian conifers were used in conjunction with natural and man-placed boulder clusters to enhance diversity.

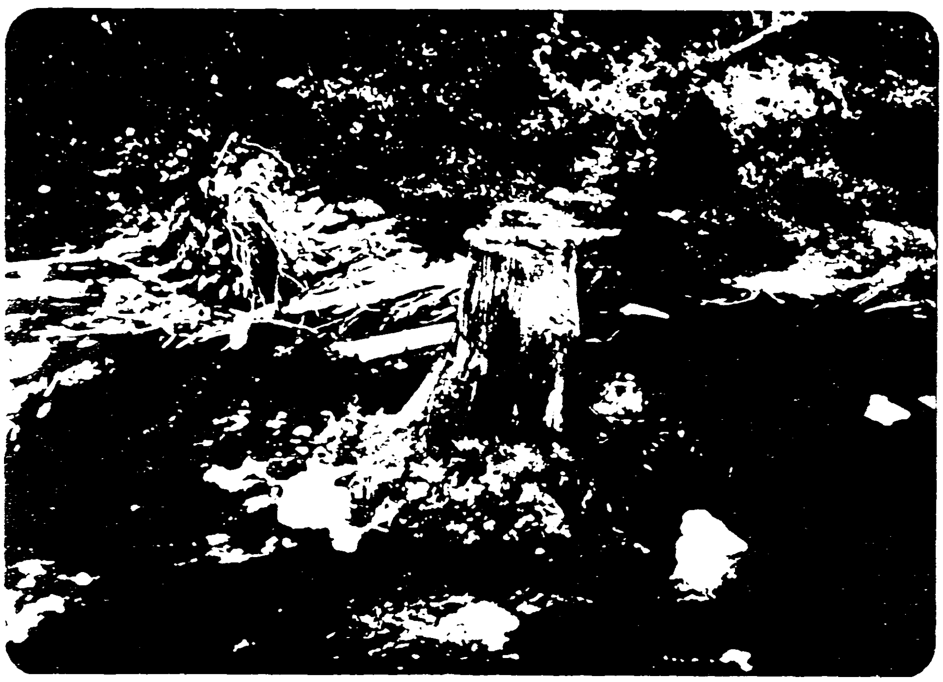
Figure 42. Lolo project: AD-reach #2; close-up of anchored debris; conifers were directionally felled at slight to moderate angles to prevent displacement.

Figure 43. Lolo project: cable technique used on anchored debris. Cable is S/16" diameter, rust-resistant. A riparian conifer lying in the channel is secured to its stump.

Figure 44. Lolo project: cable technique on felled riparian conifer. Threads on cable clamps were destroyed to prevent vandalism.

Figure 45. Lolo project: an example of a cedar stump and root wad that was rolled into the channel to provide cover and function as a deflector.

Figure 46. Lolo project: a cedar stump/root wad used with a boulder cluster in BC-reach #1. "Opportunity" debris was prevalent in Lo10 Creek.



Bank cover devices were constructed much in the same manner as described. Base "opportunity" logs were selected so that they extended 5-15 feet into the channel and LO-15 feet into the bank. The main logs were 8-10 inches in diameter. Cedar poles of 4-inch diameter were then nailed side by side from the bank to the tip of the protruding main logs (Figure 47). Usually these structures were constructed on the inside curve of meanders to provide a maximum cover effect.

Treatnent of the boulder reaches was relatively simple with the Link Belt #4500. The 36 inch yard (3) bucket with "thumb" allowed for precise placement of the boulders. The boulders were placed singly if large (>3 foot diameter) or in clusters. The clusters were arranged in either a triangular or diamond configuration with placement shading towards mid-channel. In order to achieve a "natural" appearance, the interval between boulders or clusters was varied to achieve "irregular" spacing. Often boulders were used in association with organic debris and log weirs to magnify the effect of diversity at a particular site. Entire reaches ranging in distance from 250 to 1,000 feet were treated with boulders.

Post-Construction Phase

Construction activities on the Lo10 Project were terminated in early October. For the remainder of the month, the crew worked on the restoration of disturbed sites created by project activities. These sites included access, egress, and travel routes for the backhoe--areas of soil disturbance with the riparian zone--and disturbed stream banks associated with the structures requiring excavation. Routes were water-barred and seeded with a variety of grasses. All areas of substantial soil disturbance were seeded to grasses to prevent erosion.

UPPER LOCHSA (POWELL)

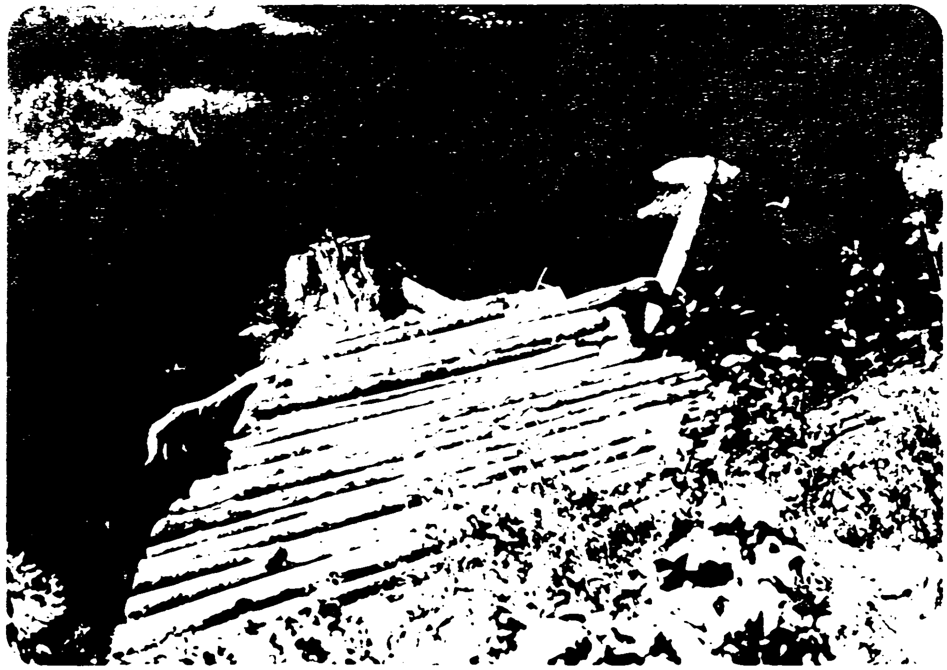
Implementation Phase

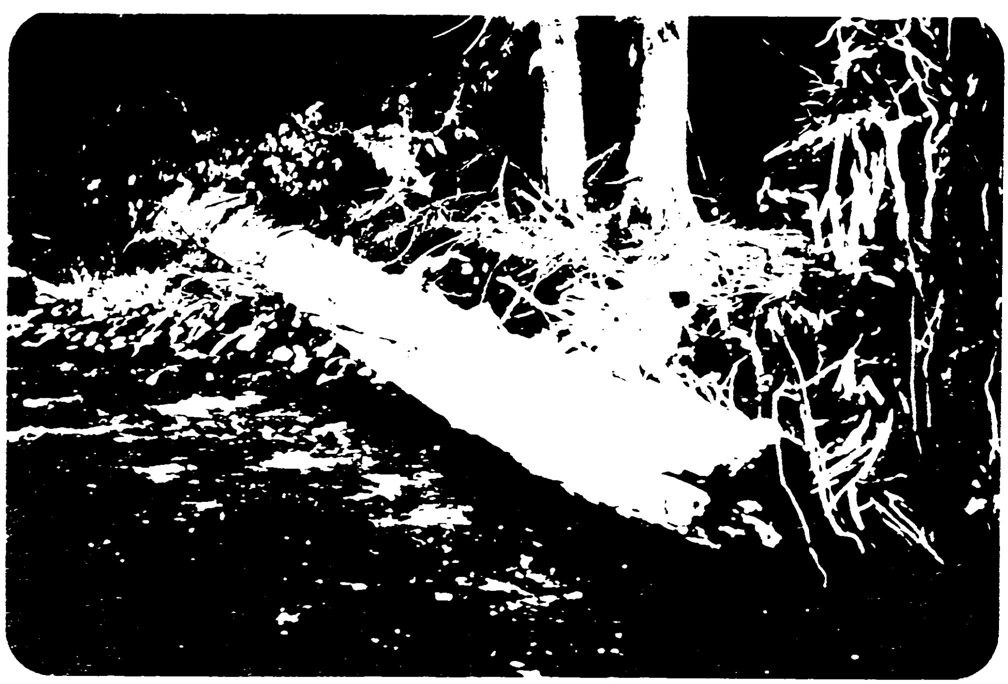
The Powell phase of the project was implemented during the first week of August. Crews and equipment were transported to preidentified reaches on the Crooked Fork by vehicle and on White Sand by pack string. The most difficult (access) and visible (adjacent to Highway 12) reaches were left to last. At first, sawyers and “fish crew" members teamed up to fell and secure the trees. During the latter stages, sawyers worked together well ahead of the crew that was slowed down by the anchoring process.

Conifers, predominantly cedar, ranging in size from 16 inches to 40 inches d.b.h. with an average of 24 inches d.b.h. were directionally felled into the channel at angles of 10 degrees to 45 degrees. The trees were felled so that 1/3 to l/2 of their length was maintained on the bank. Primarily because of the requirements of directional felling (lean and difficulty of placement) and safety, many (up to 50 percent) of the preselected trees within a reach were rejected in favor of others that would better meet the objectives and requirements. At some sites, several trees were felled in close proximity to each other to provide a cluster effect. Trees were spaced at intervals ranging from 50 feet to 300 feet with an average of 150 feet. At side channel (secondary) sites, the interval was maintalned at 50-100 feet in order to achieve the maximum effect . Upon completion of felling operations, the trees were trimmed back and debranched in some cases to reduce the potential displacement stress created by stream velocities and severe ice conditions. The crew then

Figure 47. Lo10 project: bank cover device used in association with an in-channel cedar stump. Large fish were observed utilizing these structures for overhead cover.

Figure 48. Powell (Upper Lochsa) project: natural organic debris in Crooked Fork Creek. This debris has scoured a pool and is providing cover. Our project at Powell was designed to emulate this habitat feature. Notice that the angle to the stream is slight and much of the log is on the bank.





notched the trees and some of their stumps, cabled (1/4 inch) and clamped the trees The cable was often double to the stumps and other green trees nearby. wrapped to provide extra strength. Part of the process is displayed in Figures 48-50. After each structure was secured, the crew then identified and described the structure and site on a nap and monitoring form (Appendix B). Several measurements of the structure and site were made and recorded on the form--e.g. stream gradient, d.b.h. of tree, angles with reference to the channel and bank, and percent of structure on the bank and in the channel.

Steep banks, inadequate tree size on location, and unsuitable stream substrate prevented the treatment of some areas within a reach. On the other hand, "opportunity" debris--defined as natural, in-channel organic material that was enhancing the habitat--was secured with cable to nearby anchor points. The construction phase of the project was completed in October.

Postconstruction activities included additional trimming, identification of "opportunity" debris, description, mapping, and monitoring of enhancement sites.

Figure 49. Powell project: cable technique associated with debris cluster. Cable is double-wrapped to provide extra-strength.

Figure 50. Powell project: cable technique associated with a single, large conifer. The slack in the cable length is to allow the log to pivot during high flows without over-stressing the cable.

RESULTS AND DISCUSSION OF RESULTS

Lolo Creek

A total reach distance of 8.5 miles (extensive perspective, "area of influence") was enhanced with the construction and placement of 145 habitat structures. In addition, two organic debris jams were removed during site preparation. The actual stream distance treated with structures (intensive perspective, nontreated reaches excluded) equalled 4.0 miles. The average number of structures per unit distance are: 17/mile (or 1 structure/95m) of overall reach distance and 36/mile (or 1 structure/45m) of actual distance treated. A map displaying the types, distribution, and concentration of structures is presented in Appendix C.

Sixty-nine percent of the total project activity (100 structures) was concentrated in the reach above White Creek (5.5 miles), whereas 31 percent of the total structures (45) was placed in a 3-mile reach below White Creek (Appendix C). Stream reaches exhibiting quality habitat were excluded from treatment. A categorization of total project activity, the number of structures per category, and the probable enhancement effects are presented in Table 1. Perusal of Table 1 indicates structures that created pools and enhanced pool quality were emphasized (87 percent). Significant secondary effects were sediment reduction and cover enhancement.

Five reaches of Lolo Creek were enhanced with boulder clusters with an average of 10 clusters per reach (range equals 4-16), distance per enhanced reach ranged from 200 feet to 1,320 feet (61-402m). Six reaches of the system were treated with log weirs (sills) with an average of three weirs per reach (range equals 2 - 5), distance per enhanced reach varied from 150 feet to 1,320 feet (46 - 402m). Three stream segments were improved with large organic debris (riparian trees) with an average of six units per reach, the length of enhanced reach varied from 200 feet to 1,000 feet (61 - 305m). Five stream reaches were manipulated with "opportunity" (existing) organic debris (deflectors and root wads) with an average of six units per reach. Reaches of organic debris ranged from 100 feet to 600 feet (31 - 183m). Figures 51 to 60 illustrate the various reaches, structures, and some of the effects of enhancement.

The contractual agreement between BPA and the Forest Service called for a minimum of 96 structures. We exceeded this goal by 51 percent (49 structures). This was made possible primarily because the enhancement materials such as boulders, root wads, organic debris, and suitable logs for weirs were readily available within and near the Project Area. It was not necessary to expend funds on costly logistical activities involving the location of sources and transportation of materials. Additional factors that enhanced cost effectiveness were: 1) the use of the 84500 tracked backhoe that was able to take advantage of existing on-site materials by easily handling large boulders, debris, and logs with its 36 inch bucket, and 2) an experienced, well-motivated equipment operator and "fish" crew. Table 2 displays the unit costs per structure-type. These figures do not include the costs associated with the procurement and transportation of materials. If the materials are located near the Project Area as in the case of Lolo Creek, the unit costs would be increased by 5 percent.

Figure 51. Lo10 project: post-implementation - boulder clusters reach #l upon completion. Tribidity is the result of upstream project work.

Figure 52. Lolo project: post-implementation - B.C. reach #2.

Figure 53. Lo10 project: aerial view of B.C. reach #2.

Figure 54. Lolo project: aerial view of B.C. reach #3. Interval between clusters is varied to enhance a natural appearance.

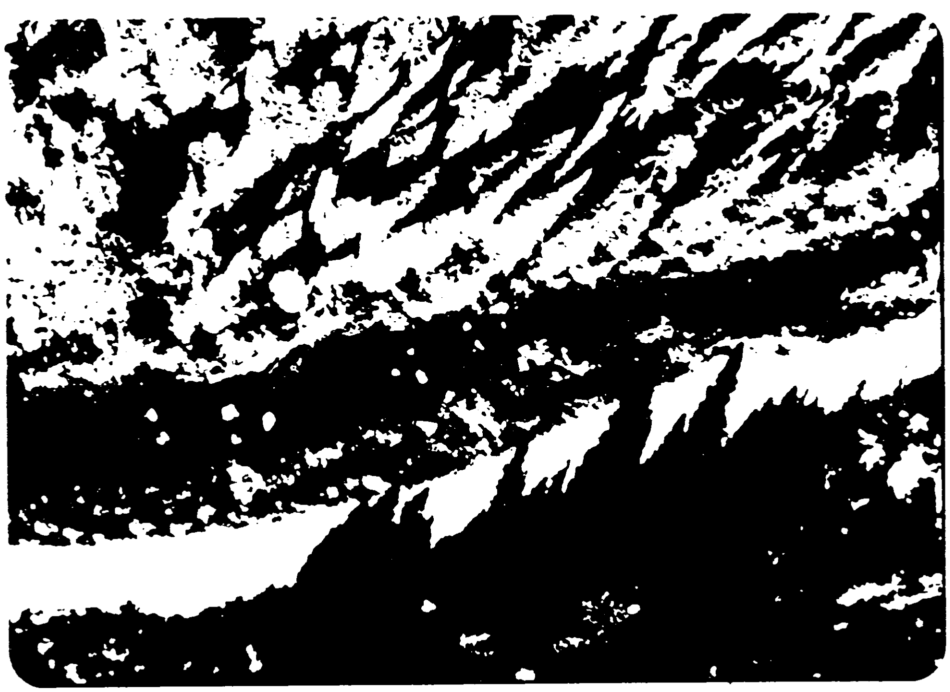


Figure 55. Lo10 project aerial view of upper log weir reach near section 10. Arrows indicate location of weirs. Notice the downstream scouring and cleansing of spawning gravels.

Figure 56. Lo10 project: aerial view of lower log weir reach near the section 6 bridge. Sorting and cleansing of gravels are evident below each weir.

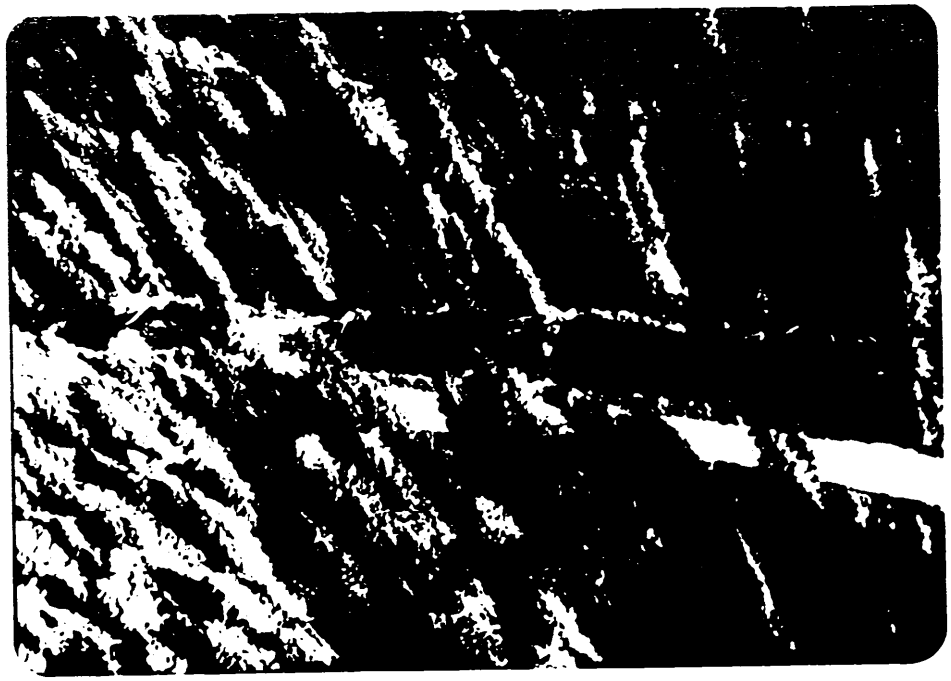


Figure 57. Lo10 project: post-implementation snorkel monitoring of weir structures (reach #1); juvenile salmon and steelhead were observed utilizing the downstream pool.

Figure 58. Lo10 project: snorkel monitoring of log weir reach #l in September.

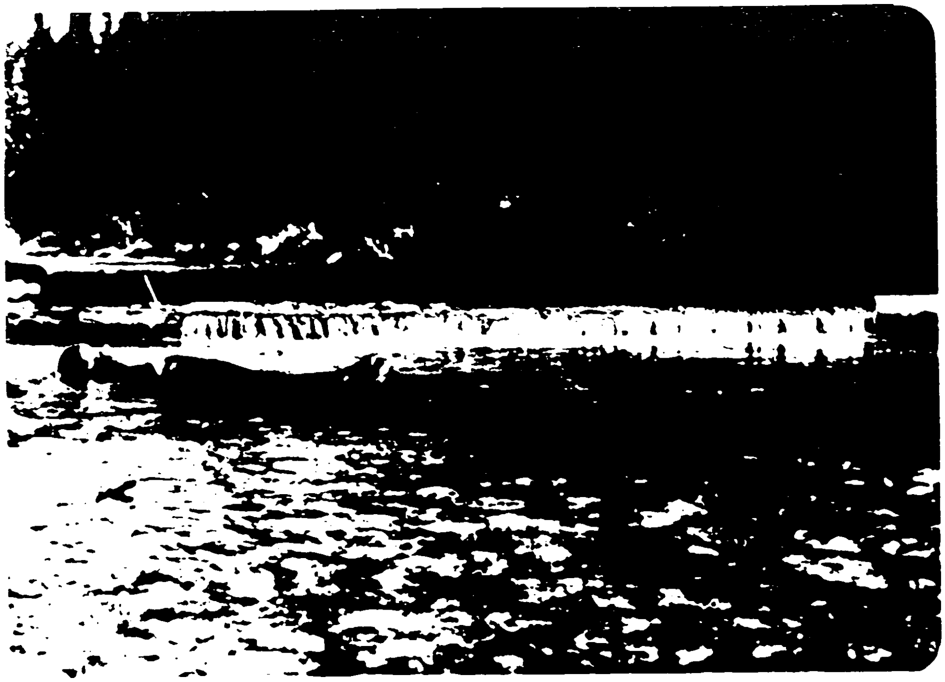


Figure 59. Lo10 project: fish population monitoring of project structures.

Figure 60. Lolo project: adult spring chinook salmon over its redd near B.C. reach 83 (September). Several pairs of chinook were observed spawning in and near our project reaches.

Observations

"K"-dams are, by far, the most costly structure employed in terms of dollars and impacts. Because of the complexity involved with constructing and attaching the wings to the main sill log, it usually took two days to complete one dam. In addition, substantially more sediment was generated during the extensive trench excavation. Unless a site demands much greater strength and stability, single log weirs as installed by a large backhoe will accomplish the same objective with much less cost and effort. Only a minimum number of "K"-dams was constructed to provide a basis for comparison against log weirs and to provide extra-stability at some sites.

Boulder clusters and anchored debris (cedar root wads) were very cost effective and may prove to be the most efficacious structures with respect to producing the manifold effects of creating pools, providing cover, and reducing sediment. With materials on-site and suitable equipment, it would be possible to complete four reaches (mean length equals 300 feet) of boulder clusters in one day. An additional attractive feature to enhancement with boulders is their more natural appearance than log check dams. Felling and anchoring riparian trees can be cost-competitive with boulders and may achieve the same enhancement effects, however, their in-chanel longevity will be much less. Bank cover devices were relatively expensive to construct primarily because of the time involved with nailing-down the overhead canopy. The same enhancement effects can be achieved with large root wads and other organic debris.

In August and September, adult chinook salmon were observed within the Project Area during their upstream spawning migration. Several were observed resting in the deep pools created by the "K"-dams and log weirs. Others were seen easily jumping over the weirs. The root wads were effectively used by the salmon for hiding cover. Some of the chinook did spawn in the "tail-outs" of pools created by the Project. Others spawned near our enhancement reaches during construction activities (Figure 60). As part of our annual, population monitoring program in Lolo, several of the "K"-dams and log weir pools were sampled in early September by snorkel diving (Figures 57-59). Juvenile salmon and steelhead were observed in every pool. Sampling of five "enhanced" pools revealed juvenile fish densities of: steelhead 0+ = 14/lOOm2, l+ and 2+ = 3.7/100m2, and chinook salmon 0+ = 5/100m2, whereas, sampling of three "nonenhanced" (control) pools displayed: steelhead 0+ = 12/100m2, l+ and 2+ equals 9.4/lOOm2, and chinook salmon 0+ = O/lOOm2. The combined (all age classes) anadromous fish densities for the two areas are virtually the same: 23 fish/lOOm2 for "enhanced" and 22 fish/l00m2 for the control. At this point, however, it is much too early for comparisons between treated and nontreated stream reaches.

The enhancement of habitat in Lo10 Creek did generate some controversy because of the use of heavy equipment within the stream channel and the sediment produced during excavation. Several local newspaper articles were written to handle the public's concern and inform them of the Project activities. The level of criticism significantly diminished after the articles were printed. The long term enhancement of habitat will fully mitigate the short term impacts the system experienced during implementation.

TABLE 1. Types of habitat structures, number per type, and probable enhancement effects of structures placed in Lolo Creek, Idaho.

Type	No.	Probable Effect(s)
K-Dams	9	Pool Formation Sediment Reduction
Log Weirs (Sills)	29	Pool Formation Sediment Reduction
Lateral Deflectors (repositioning and anchoring existing organic debris)	16	Pool Formation Sediment Reduction Cover Enhancement
Large Organic Debris (felled and anchored streamside trees)	19	Pool Formation Sediment Reduction Cover Enhancement
Cedar Root Wads	15	Cover Enhancement Pool Formation
Boulder Clusters (boulders)	53 (133)	"Pocket-water" Pool Formation Cover Enhancement Sediment Reduction
Bank Cover Devices	3	Cover Enhancement
Pool Construction (below natural deflector)	1	Pool Formation

TOTAL STRUCTURES = 145

TABLE 2. Project costs per unit-structure type for habitat enhancement in Lo1o Creek, Idaho.

STRUCTURE TYPE	UNIT COST(S)*
"K"-Dam (complete)	$1,400
"K"-Dam (modified) (reduced wing structure)	$ 700
Log Weir (backfill with equipment)	s 350
Boulder Cluster (ave. 2.5 boulders per cluster)	$ 55 ($22 per boulder)
Bank Cover Devices	$ 400
Anchored Organic Debris (existing in or near channel)	$ 28
Felling and Anchoring Riparian Trees	$ 55

Average Project Cost For all structure types = TOTAL BUDGET / Total structures = $27,000 / 145 = $186/structure

* Add 5 percent to costs for procurement of materials.

RESULTS AND DISCUSSION OF RESULTS

Upper Lochsa (Powell)

A total stream distance of 9.1 miles was enhanced on Project streams (extensive perspective): seven reaches and a total of 5.65 miles on Crooked Fork; five reaches and 3.45 miles on White Sand. Approximately 40 percent of the stream's length proved to be unsuitable for treatment because of steep banks, stream gradient, high energy sites, and unsuitable riparian trees. Therefore, from an intensive perspective, a total distance of 5.5 miles was enhanced. The Project crew felled a total of 200 conifers with 122 going down in Crooked Fork and 78 in White Sand.

In addition to felling riparian trees, "opportunity" debris (O.D.'s) that was enhancing the habitat was cabled to nearby anchor points. A total of 63 O.D. units (24 percent of total project structures) was secured for both streams. The Project enhanced a total of 194 sites with 118 in Crooked Fork and 78 in White Sand. Tables 3 and 4 display pertinent project statistics.

In Crooked Fork, the average number of enhancement structures per mile of reach equalled 30 (22 felled conifers). On the basis of actual reach treated, the average is 50 structures per mile (36 conifers/mile). The former equates to an interval of 176 feet (54 m) per structure and the latter to an interval of 106 feet (32 m) per structure.

However, the distribution of structures did not follow a set, equal interval of spacing. The number of structures per reach also displayed considerable variation (range = 5 - 78 in Crooked Fork). Examples of general and specific patterns of distribution are displayed in Figure 4 and appendix D.

In White Sand Creek, the mean number of structures per mile of reach equalled 27 (23 conifers), whereas, on the basis of actual treatment, it equates to 45 units per mile (38 conifers). These figures convert to 196 feet (60 m) per structure and 117 feet (36 m)/structure.

Opportunity debris varied from 16 percent in White Sand to 28 percent of total structures in Crooked Fork.

Within the Project reaches, ten (9 in Crooked Fork) secondary channels were evaluated for treatment. Eight (7 in Crooked Fork) were suitable for treatment. Four of these channels were the focal points of concentrated enhancement effort - that is, the mean interval between structures was reduced to 50-100 feet where possible; thereby, increasing the number of structures per lineal stream distance. The number of structures per channel ranged from 3-14 with an average of eight. These secondary channels varied in length from 475 to 4200 feet with an average of 1900 feet.

Figures 61 to 68 illustrate the Project activities, enhancement sites, and results.

The work statement for the Powell segment of the Project called for enhancement of two, ten-mile reaches at a frequency per interval of 20 trees per mile.

Primarily because of the checkerboard, mixed ownership pattern in both drainages (50 percent Federal in Crooked Fork and 17 percent in White Sand), only 13 miles were actually available for enhancement. Although contacted frequently and their participation solicited, the Plum Creek Timber Company declined to participate in the project. Therefore, because of this and the in situ factors mentioned previcously, it was not possible to achieve the overall objective of 400 trees.

Of those reaches evaluated and enhanced, we did exceed the unit frequency per interval by two trees (22 trees/mile). When O.D.s are considered, we exceeded the frequency objective by 9 structures/mile. In relation to the overall objective, we achieved a level of 66 percent (2631400).

The unit cost per felled riparian conifer for the project equalled S120/tree and Per anchored organic debris (O.D.'s included) it was $91/structure. Enhancement with organic debrs at Powell was more costly (54%) than at Lolo because of the larger trees and the difficulties with logistics (access in roadless areas).

Table 3. A Compilation of Project Statistics for White Sand Creek, Idaho

Reach	Distance* (miles)	Trees Felled	Dominant Species Felled	Enhanced Sites	OD's	Total Structures
l-TB	0.40	12	Cedar-58%	14	6	18
2-CR	0.30	5	Larch & Fir 40%	5	0	5
3-CCR	0.75	21	Cedar-76%	17	2	23
4-BCR	0.50	11	Cedar-45%	9	0	11
5-CCCR	1.50	29	Larch-55%	31	7	36
Summary	3.45	78	Cedar-36%	76	15	93

* 40% of reach distance was unsuitable for treatment.

Table 4. A Compilation of Project Statistics for Crooked Fork Creek, Idaho

Reach	Distance* (miles)	Trees Felled	Dominant Species Felled	Enhanced Sites	OD's	Total Structures
l-TB	0.40	7	Cedar-57%	5	0	7
2-DR	1.00	17	Cedar-59%	17	8	25
3-RAD	0.75	3	Fir-67%	6	7	10
4-3/4 s	0.80	14	Fir-64%	14	3	17
5-Hwy 12B	0.70	25	Spruce-92%	18	0	25
6-Hwy 12A	1.00	33	Spruce-73%	36	24	57
7-Ford	1.00	23	Spruce-70%	22	6	29
summary	5.65	122	Spruce-52%	118	48	170

*40% of reach distance was unsuitable for treatment.

Figure 61. Powell project: implementation phase; debris cluster in Crooked Fork (Devoto reach); notice the slight angle to the channel bank; limbs on the upstream face were trimmed to minimize the effects of icing.

Figure 62. Powell project: implementation - large riparian conifer in the corner reach of White Sand Creek.

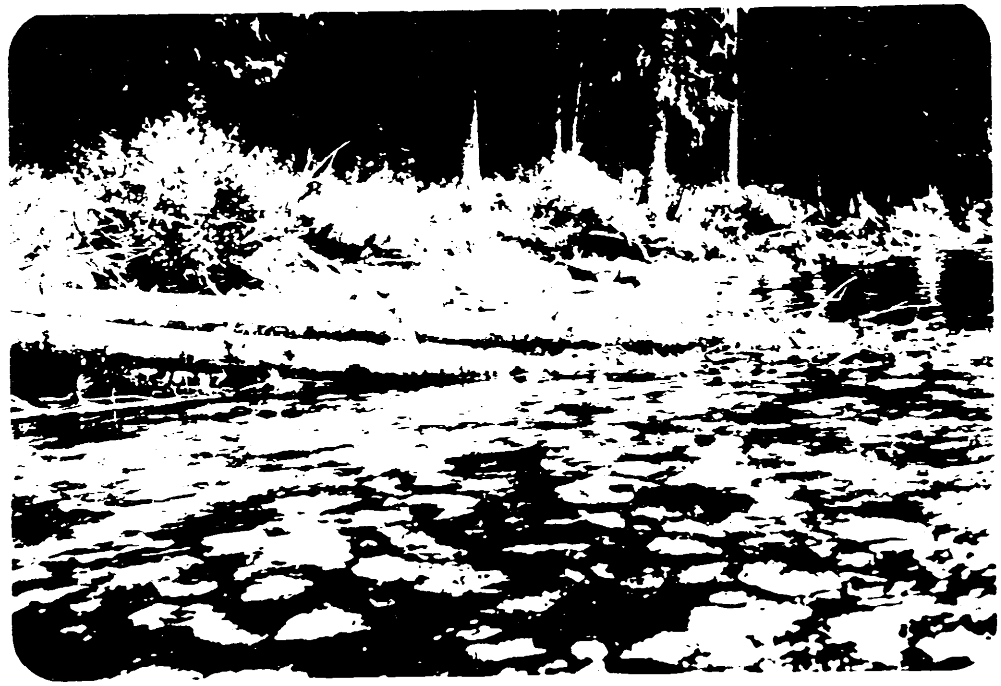


Figure 63. Powell project: a tri-conifer cluster in the Cabin Creek reach of White Sand Creek; multiple units (clusters) were used to optimize the enhancement effect and provide extra stability.

Figure 64. Powell project: debris cluster in Crooked Fork (above Highway 12 bridge); these trees were directionally felled so that they were buttressed by the boulders.

Figure 65. Powell project: aerial view of anchored debris in the Twin Bridges reach of Crooked Fork.

Figure 66. Powell project: debris structure at site #25 in Crooked Fork; trees were often topped to minimize drag at higher flows.

Figure 67. Aerial view of the project structures in the Beaver Creek reach of White Sand Creek.

Figure 68. Another aerial view of the Beaver Creek reach of White Sand.

SLJMMARY AND CONCLUSIONS

1. In FY 1983, Phase I of the Lo10 Creek and Upper Lochsa Habitat Enhancement Project was initiated and completed.

A. The project (#83-522) was funded at $55,927 dollars.

B. One hundred percent of the budget was expended in executing project activities.

2. A total of 145 habitat structures were placed in Lolo Creek and 263 in the project streams of the Upper Lochsa.

A. Eighty-seven percent of the structures in Lolo dealt with improvement of pool frequency and quality.

B. Two hundred riparian conifers were felled and anchored in the Upper Lochsa streams (122 in Crooked Fork and 78 in White Sand).

3. A total stream distance of 8.5 miles in Lolo Creek was enhanced by altering the pool-riffle ratio from 30:70 to the more "Classical" 40:60 to 50:50. The degree of enhancement equates to 35 acres of summer/winter rearing habitats and 6.5 acres of spawning habitat.

The overall enhancement objectives are to: improve 40 to 60 acres of summer/winter rearing habitats, and 10 to 14 acres of spawning habitat. During Phase I, we have accomplished 88 percent of the low range figure for rearing habitat and 65 percent of the low figure for spawning habitat.

4. During Phase II in Lolo (FY 84), we can enhance the remaining 3.5 miles of stream reach, 5-25 acres of rearing habitat, and 3.5-7.5 acres of spawning habitat.

5. In our opinion, we have increased the diversity, utilization, and productive capability of Lolo's fish habitat with this project.

A. Whether or not it achieves the estimated increases in salmon and steelhead smolt production (10,000 chinook and 4,000 steelhead) is a matter for evaluation by the Idaho Department of Fish and Game.

6. We feel that the Lolo phase of the project has been successful. An interagency (State, BPA, and Forest Service) review of the project conducted in October concurred with this opinion.

7. The overall average cost per habitat structure in Lo10 was $186/structure.

8. In September, juvenile salmon and steelhead were observed via snorkel diving utilizing the habitat created by the project.

9. On the Upper Lochsa, a total stream length of 9.1 miles was enhanced on Crooked Fork (5.65 miles) and White Sand (3.45 miles). Diversity and the amount of hiding cover (rearing habitat) was increase:! over 58 acres of Crooked Fork and

36 acres of White Sand by the felling and anchoring of riparian conifers and organic debris. In relation to the objective of 60-75 acres, we have exceeded it by 25 percent.

A. With respect to increasing the amount (20%) of spawning habitat and improving the pool/riffle ratio towards a balance of 50:50, a test of time and evaluation will be required. If the structures hold over time (7-10 year-), then they will sort and collect spawning gravel and scour pools. Idaho Department of Fish and Game will evaluate whether or not the habitat and population objectives for the Upper Lochsa streams are attained.

B. Although the scope of the project was limited by mixed ownership and in situ channel variables, we feel that it was successful because we did improve the quality of habitat extensively over 92 acres and intensively over 56 acres of summer/winter rearing habitats.

10. A total of 263 debris structures (200 felled riparian trees) was placed into project streams: 170 in Crooked Fork and 93 in White Sand.

A. Seven stream reaches and 118 sites were enhanced in Crooked Fork.

B. Five stream reaches and 76 sites were improved in White Sand.

C. The project attained a 66 percent level of accomplishment with respect to the overall goal of 400 habitat structures.

11. Stream reaches under private ownership constitute an opportunity for future enhancement; 5-8 miles are available and suitable for improvement with organic debris.

A. It is recommended that the Idaho Fish and Game Department negotiate with the Plum Creek Timber Company for approval or an easement.

12. Unit costs per structure were:

$120/riparian tree; $9l/organic debris (both types).

A. Enhancement with organic debris at Powell was 54 percent more costly than at Lolo because of complexities associated with access and logistics.

B. Phase II enhancement (FY 84) will involve the removal of migration barriers on Upper Crooked Fork and maintenance of the debris structures in White Sand and Crooked Fork Creeks.

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Acknowledgements

Wally Murphy and Rich Gritz were major contributors to this project and report. I thank them for their efforts. The success of this project was largely attributable to the efforts of our "fish habitat crews" at Pierce and Powell. I would especially like to thank Wayne Paradis, Bob Vogelsang, and Mike Haberman for their fine work in Lolo Creek. Wendell Osborne, our heavy equipment operator at Lolo, deserves special recognition for his hard work, interest, and "artistry" with the backhoe. Our crew at Powell-Dave Gordon, Rich Doss, and Jeff Butler deserves a special thank you for their quality work.

We would like to thank Larry Everson, BPA Contracting Officer, for his help and support throughout this project.

APPENDICES

APPENDIX A

BPA - LOLO CREEK PROJECT 1983

BPA - POWELL PROJECTS 1983

Criteria for Selecting Boulder Cluster Reaches:

1. Substrate relatively large - large and small rubble.
2. Areas lacking pocket water, pools, cover, and diversity.
3. Nonspawning areas (crests of riffles).
4. B-Channel reaches (higher velocity areas).
5. Habitat types exhibiting extensive shallow riffles and runs.

Criteria for Selecting Reaches Suitable for Lateral Log Deflectors:

1. Stable banks.
2. C-Channel reaches (lower velocity areas).
3. Areas lacking cover, diversity, and pools.
4. Near spawning areas - but not on crests of spawning riffles.
5. Near thalweg - away from inside back of meanders.
6. Near (head-end areas) of heavily sedimented reaches.
7. Select areas where large cedar stumps are available - substitute for wedge deflectors.

Criteria for Selecting Reaches and Sites Suitable for Log Sills and K-Dams:

1. Stable banks (both sides). No road riprap banks.
2. In areas lacking pools, pool quality, cover, and diversity.
3. Away from fair-to-good spawning areas; away from riffle crests.
4. C-Channel reaches; away from gradient changes.
5. Near the head-end of reaches that are heavily sedimented.
6. Relatively straight reaches - avoid tight meanders.
7. Near areas where onsite materials are available - i.e., existing inchannel debris and riparian conifers (20-26" dbh).

Criteria for Selecting Reaches and Sites Suitable for Anchored Organic Debris:

1. Areas lacking cover, pools, pool quality, and diversity.

2. Avoid riffle crests.

3. Near spawning areas.

4. B and C channel reaches.

5. Near the head-end of reaches that are heavily sedimented and embedded.

6. Avoid higher velocity areas - gradient changes.

7. Near sites where onsite materials exist - i.e., existing inchannel debris and available riparian conifers (20-26" dbh).

8. Avoid taking (cutting) bank stability trees.

9. Fell trees so that the angle between the channel edge and the debris does not exceed 20 degrees.

10. Do not fell trees from high channel banks or terraces or steep side slopes.

11. Select and fell trees so that at least 30 percent of the butt length is on the bank.

12. Do not select snags for debris sources.

13. Favor spruce, larch, Douglas fir, and cedar over grand fir, white pine, and cottonwood.

14. In large systems such as White Sand and Crooked Fork Creeks, use 2-3 trees for your debris unit structure.

15. Favor backwater channels (smaller) for debris sites in large systems.

16. In systems with lesser opportunity, shorten the interval between debris units to 50'-lOO'-150'.

17. Select sites on the inside curves of meanders - areas of lesser velocity and depth. Avoid the thalwey and areas of higher velocity.

18. If possible, cable to the stump and l-additional live tree.

19. Take advantage of "opportunity" debris - cable to live trees.

APPENDIX B

Stream: White Sand (section 34) Site #7

O.D. or Live Tree Type: 1 spruce, 1 cedar, 1 larch O.D.

# of Structures: 3 dbh: cedar - 12", spruce - 28", larch, O.D. - 26"

Location: Right bank, 50 yards up from site #6

Type of Reach: A) Inside meander, outside meander, straight
B) Shallow, average, deep

Stream Substrate: Large rubble

Relative Stream Energy: High, medium, low

Stream Gradient: 1%

Gradient: A) Perpendicular, bank to stump 15%
B) of structure(s) 6%

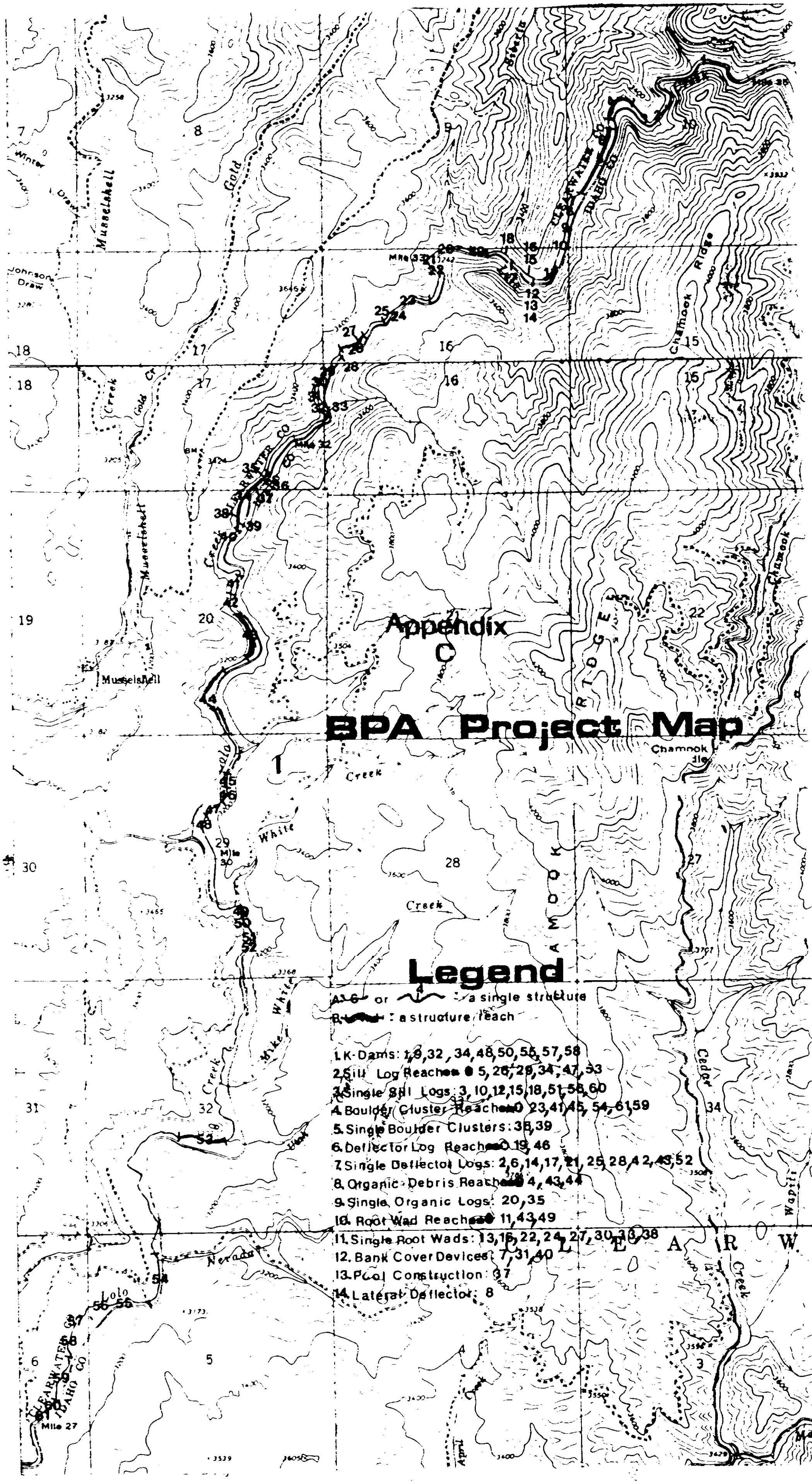
Angle: 30 degrees

Percentage of structure for spruce on bank: 60- over water 40.

How cabled: Larch O.D. - cabled to cedar tree on bank.
Spruce - not cabled (keyed in very well).
Cedar - cabled to spruce.

Exposure: #7a, 7b, 7c, 7d, 7e.

Comments: 12" cedar pushed over during the felling of the spruce it is at a 90 degree angle. The spruce is keyed in between four alternative trees.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C
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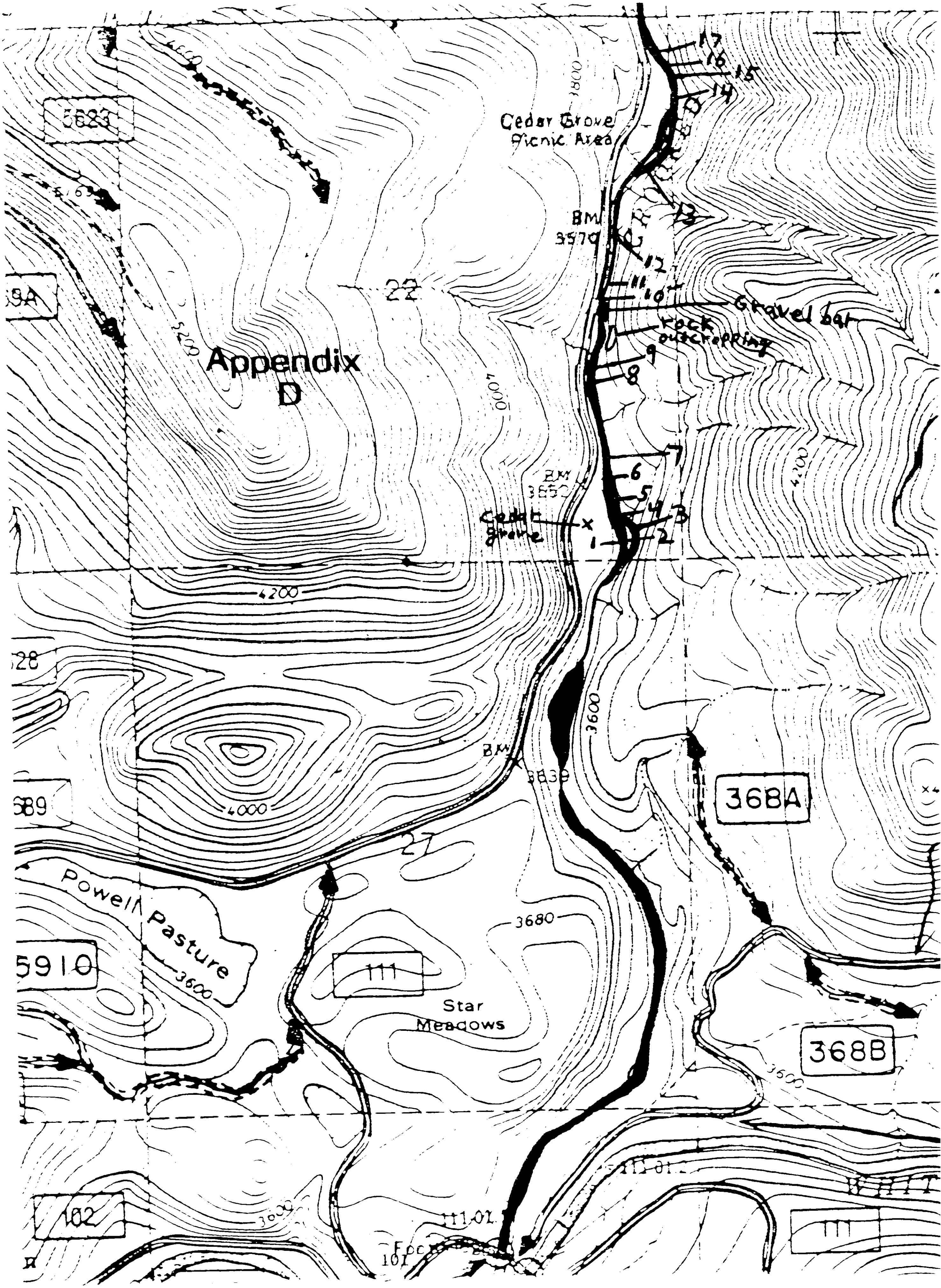
13. Pool Construction: 37
14. Lateral Deflector: 8
Musselshell
Johnson Draw
Gold
Creek
Lolo
White
Nevada
Chamook Ridge
Cedar
Wapiti
Mile 32
Mile 30
Mile 27
CLEARWATER CO
IDAHO CO



Appendix
D
Cedar Grove
Picnic Area
BM
3570
BM
3650
BM
3639
Cedar
Grove
Gravel bar
rock
outcropping
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
22
27
4200
4000
3800
3680
3600
368A
368B
5910
111
102
111.01
Powell Pasture
Star
Meadows

APPENDIX E

Summary of Expenditures*

Salaries	$23,631.75
Travel	480.46
Nonexpendable Equipment and Material	0
Expendable Equipment & Material Overhead	0
Operations and Maintenance (includes mileage for vehicles)	$22,405.96
Total	$46,518.17

* Total expenditures as of quarter ending September 30, 1986. Projected estimate of expenditures at close-out equals 100 percent of allocated budget of $55,927.

A BIOLOGICAL AND PHYSICAL INVENTORY OF THE STREAMS WITHIN THE LOWER CLEARWATER RIVER BASIN, IDAHO

by

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Post Office Box 365

Lapwai, Idaho **83540**

An Annual Report for the 1983

Field Season Submitted to the

Bonneville Power Administration

March, 1984

A C K N O W L E D G M E N T S

The Nez Perce Tribe of Idaho, through their commitment to conservation and enhancement of anadromous salmonid fishery resources and supporting habitat, extended the administrative support necessary to complete this project. This study was supported entirely by the Bonneville Power Administration. Thanks are also due Manuel Villallobos, Chris Webb, Melisa Oat-man,Mia Sonneck and Levi Taylor who assisted during field portions of the project.

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EXECUTIVE SUMMARY

Juvenile rainbow-steelhead trout were found at varying densities on all stream systems surveyed within the lower Clearwater River Basin with the exception of Cottonwood Creek (SF tributary). Juvenile chinook salmon were found at the mouths of a few creeks, but production was identified only in Lolo Creek.

All systems within the lower basin showed signs of watershed degredation. The primary cause of the stream degredation was variation of annual stream flow. High peaks in flow have scoured stream channels, which has resulted in a lack of instream cover and riparian vegetation; a situation not conducive to salmonid production.

Two streams were identified to have the most enhancement potential. Based on waterflow, general watershed degredation (sedimentation) and number of anadromous fish species present. Lolo Creek, and Big Canyon Creek were identified in order of priority. Clear Creek, Orofino Creek, and Potlatch River also among the largest streams in the lower Clearwater River Basin need additional baseline data to recommend enhancement activities.

INTRODUCTION

Historically, tributaries of the lower Clearwater River supported runs of anadromous salmonids. These fish were utilized by the Nez Perce Tribe for subsistance, trade and religious ceremonies. Fishing was as important to their annual subsistance as hunting and root gathering (Morrison-Maierle 1979). Both the procurement and consumption of both salmon and steelhead trout comprised an intergal component of the tribes cultural and religious beliefs.

Presently, anadromous salmonid stocks returning to Idaho are greatly reduced from historical levels. Since 55% of all steelhead, 39% of all spring chinook and 45% of summer chinook produced in the Co-umbia Basin originated in Idaho (Mallet 1974), this reduction impacts the entire basin fishery. Since **most** anadromous salmonid habitat in Idaho lies within the ceded lands of the Nez Perce Tribe, the tribe is deeply interested in the status and management of these anadromous streams.

There are very little data depicting the magnitude of the anadromous salmonid resource within the lower Clearwater Basin. The majority of these streams flow entirely or in part on the Nez Perce Reservation. The Tribe therefore, undertook a survey of these streams with support by the Bonneville Power Administration (BPA) to generate a data base for future enhancement and management decisions.

STUDY SITE

The Nez Perce Indian Reservation, located in north central Idaho, is about 3237 km2 in area, and includes a substantial portion of the lower Clearwater River drainage, (the mainstem Clearwater River and portions of the North Fork, Middle Fork and South Fork). This report concludes the second summer of an inventory which included most streams which flow entirely or in part within the reservation, i.e.,the entire lower Clearwater River Basin (Figure 1). Elevations in the lower Clearwater Basin range from 280 m to 1,844 m. Reflecting these elevations, general habitats include semi-arid canyons, agricultural prairie and coniferous forest. Average annual rainfall, recorded in Lewiston, Idaho from 1973 to 1982, averaged 31.6 cm, although considerably greater rainfall occurs in the higher elevations. Air temperatures during the summer low periods range from 37.7 C at the lower elevations to 26.6 C in the forested highlands. Dworshak National Fish Hatchery, located within the Reservation, was established as mitigation for the construction of Dworshak Dam on the North Fork of the Clearwater River. Dworshak is a source for extensive outplanting of steelhead smolts throughout the drainage. Fish species found in the lower Clearwater Basin are listed in Table 1.

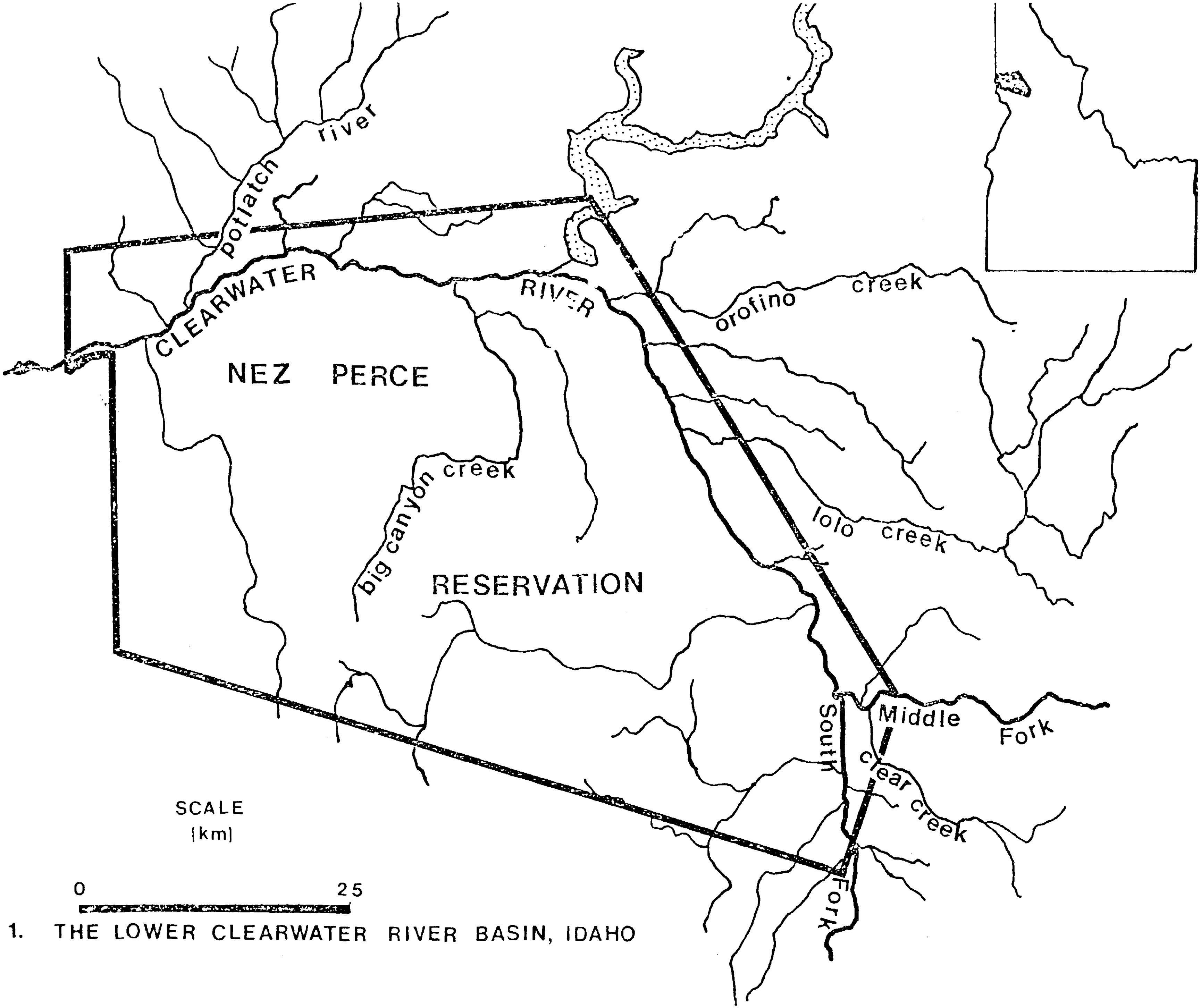

FIGURE 1. THE LOWER CLEARWATER RIVER BASIN, IDAHO

Table 1. List of fish species sampled in the streams within the lower Clearwater River Basin, Idaho, from July to October 15, 1983.

Common Name	Scientific Name
Rainbow-Steelhead Trout	*Salmo aairdneri*
Chinook Salmon	*Oncorhvnchus tshawvtscha*
Kokanee Salmon	*Oncorhvnchus nerka*
Bull Trout	*Salvelinus confluentus*
Cutthroat Trout	*Salmo clarki*
Mountain Whitefish	
Smallmouth Bass	*Micropterus dolomieui*
Longnose Dace	*Rhinichthys cataractae*
Speckled Dace	*Rhinichthys osculus*
Paiute Sculpin	*Cottus beldingi*
Torrent Sculpin[a]	*Cottus rhotheus*
Northern Squawfish	*Ptychocheilus oreqonensis*
Chiselmouth	*Acrocheilus alutaceus*
Redside Shiner	*Richardsonius balteatus*
Bridgelip Sucker	*Catostomus columbianus*
Largescale Sucker	*Catostomus macrocheilus*
Pacific Lamprey (ammocoete)[a]	*Entosphenus tridentatus*

[a] Probable species identification.

METHODS

All streams selected for evaluation were visually surveyed for barriers to fish migration, water diversions and general habitat types. The entire length of each stream was surveyed on foot where it was practical. Once general habitat types were identified (i.e., canyon, meadow and forest), a representative station was established in each of these habitats where access permitted. These stations were identified by their stream mile location and labeled 1, 2, 3, etc. from the lowest station to the uppermost station on each stream. Each station consisted of a discrete 60 to 100 m section of stream, from which, population estimates of salmonid fishes and an assessment of stream habitat were recorded.

Population Determination

To assess populations of salmonids it was necessary to utilize two schemes. In waters with sufficient conductivity, a Georator portable generator (Model 31-002) with single electrode set at 230 volts direct current was used to collect fish. Fish population estimates were conducted at each location using the removal method (Zippin 1958; Seber and LeCren 1967). The specific program utilized for population estimates can be found in Platts (1983). During the removal procedure fish were shocked from down to upstream, in a discrete section with block nets in place at both ends. Between passes-fish were kept in large plastic garbage cans. All salmonids were weighed to the nearest gram and measured (total length and fork length), to the nearest millimeter-

In streams where the conductivity was too low to enable efficient capture of salmonids, population estimates were made by direct observation using a snorkling technique (Platts 1983). These observations, while accurately depicting the populations, did not provide biomass information. For this reason the snorkler identified salmonid fishes as subyearling, or overyearling fish (Griffith and Fuller 1979). Two observation runs were made from down to upstream. The average of the two counts was used to make a conservative population estimate. A sample of fish was collected with the Georator and mean lengths and weights were determined for the size groups identified by the observer.

These population data were then used to generate standing crop estimates (Biomass k/ha) and density (fish/m2) for each of the two size groups (i.e., subyearling and overyearling).

In addition to the biological data concerning the biomass and abundance of rainbow-steelhead trout, each station surveyed was characterized by measuring twelve physical parameters and thirteen chemical parameters. The physical attributes were chosen as those most likely to affect production of rainbow-steelhead trout either singularly or synergistically as described by Binns and Eiserman (1979) and the U.S.D.I. Forest Service Ocular Method.

Physical Attributes

Late Summer Stream Flow

Estimate of flow (m3/sec) taken during low flow periods associated with late summer conditions. This attribute, considering depth is an indicator of the space available to fish during the critical low flow period. Chapman (1964) identified space as one of the two critical elements regulating salmonid populations in streams.

Annual Stream Flow Variation

A subjective estimate of variation in flow as observed from flood damage, channel scouring and water flow records. This parameter describes the consistency found in a stream environment. Extreme annual fluctuations in flow can displace eggs, and subyearling fish, and erode adjacent stream banks and cover (Meeham 1974).

Maximum Summer Temperature

Maximum water temperature C recorded with Taylor Min-Max thermometers during the low flow period. Temperature is a prime regulator of natural processes within the aquatic environment. It limits physiological functions of not only fish but all biological constituents of the ecosystem. Temperatures greater than 22.2 C have been shown to inhibit salmonid production (Mackenthun 1969), therefore this value was used to provide the upper lethal limit for rainbow-steelhead trout in this report. Temperatures greater than 22.2 C were considered lethal to salmonids.

Instream Cover

Total measured surface area of cover for overyearling rainbow-steelhead trout (surface turbulence, overhanging vegetation, depth, submerged objects and undercut banks, (Binns and Eiserman 197)). Recorded as % of total stream area.

Water Velocity

Average stream velocity was calculated from the timing of dye (Binns and Eiserman 1979). The velocity of water movement is extremely important to aquatic organisms in a number of ways including the transport of nutrients and organic food pass those organisms attached to stationary surfaces or feeding locations. In addition, the amount of oxygen available and the speed which sediments can be transported down stream are related to this parameter (Mackenthun 1969). Velocity determines those species of stream bed organisms that may be present and the size and species of fish that utilize a stream. Bovee (1978) identified the optimum range of velocities utilized by juvenile rainbow-steelhead using probability-of-use methodology. Water velocities identified in this study are related to these curves.

Stream Width

Width of stream at the water surface (m). This parameter, considered with stream depth, describes the potential habitat within a stream.

Stream Depth

Mean stream depth from multiple transects (cm). Past research within the Clearwater system {Everest and Chapman 1972) have shown utilization of specific water depths by rainbow-steelhead. Bovee (1978) identified optimum depths for juvenile rainbow-steelhead trout using probability of use methodology which included work by Everest and Chapman (1972). Water depths identified in this study are related to these curves.

Cobble Embeddedness

The extent to which the cobble in the substrate is covered by silt or sand (8). Deposition of sediments in streams can and often does destroy aquatic insect populations (Mackenthun 1969). Bjornn et al (1977)found that sediment in the substrate can limit salmonid production in streams and Meehan (1974) indicated that not only the sediment present in the substrate but also the transport of such sediment can decrease the production of salmonids. This study is limited to the sediment present in the substrate during the low flow period and will be compared to the quantitative work describes by Bjornn et al (1977).

Major Substrate

The primary substrate size present by precent (Lane 1947) (American Geophysical Union). Everest and Chapman (1972) found that rainbow-steelhead trout tended to utilize specific sizes of substrate within the Clearwater Basin. Bovee (1978) identified optimum substrate sizes for rainbow-steelhead juveniles using probability of use methodology. The substrates identified in this study are compared to the curves developed by Bovee (1978),

Periphyton Coverage

Coverage (% of total area) of substrate by periphyton. The presence of periphyton (algae in and around the substrate) is an indicator of the quantity of primary productivity and related nutrient sources available within a stream.

Pool Riffle Ratio

Percentage of total area of stream habitat which is either of a pool or riffle nature. In a well balanced stream it is generally recognized that a ratio between 60:40 to 40:60 provides adequate zones of production for aquatic insects and areas with sufficient depth to be utilized by fish. This report uses this ratio as a general indicator of pool habitat quantity for rearing juvenile rainbow-steelhead.

Water Quality samples were collected in one quart plastic containers and immediately labeled,' cooled in ice and transported to the Analytical Services Laboratory at the University of Idaho the same day. Parameters measured, methodology and detection are presented in Table 2.

Streams reported in this paper were inventoried during the summer 1983 from mid July to October. This was accomplished by sampling stream of lower elevation and smaller watershed earliest and the higher elevation streams toward the seasons end. Data is also reported from stream surveys that were originated in 1982 and completed in 1983 (Kucera et al 1983). As orginally proposed and reported in Kucera et al (1983) the Habitat Quality Index (HQI) of Binns and Eiserman (1979) was not used as an analytical tool. The inability to produce a model appropriate to the anadromous fish and theirrelation to habitat parameters has limited the value of that method in this application.

Table 2. Water sample analysis outlining constituents measured, methods of detection and detection limits for samples taken from the streams on the lower Clearwater River Basin, Idaho, from July to October, 1983.

Constituent	Detection Method	Detection Limit
Carbonate, CO_3	Titrimetric-H_2S0_4 and phenolphthalein	0.22 mg/l
Bicarbonate, $HC0_3$	Titrimetric-H_2S0_4 and methyl orange	0.09 mg/l
Sulfate, $S0_4$	Turbidimetric	1.0 mg/l
Nitrate, $N0_3$	Colorimetric, automated, cadmium reduction	0.01 mg/1
Orthophosphate, PC_4	Colorimetric, automated, ascorbic acid	0.01 mg/1
Chloride, Cl	Titrimetric-Silver nitrate and potassium chromate	0.01 mg/1
Calcium, Ca	Inductively Coupled Plasma-Atomic Emission Spectrometer	0.15 mg/1
Magnesium, Mg	Inductively Coupled Plasma-Atomic Emission Spectrometer	0.25 mg/1
Sodium, Na	Inductively Coupled Plasma-Atomic Emission Spectrometer	0.10 mg/l
Potassium, K	Inductively Coupled Plasma-Atomic Emission Spectrometer	0.50 mg/l
Total Dissolved Solids	Gravimetric	'10.0 mg/l
PH	Colorimetric	0.1 unit

All biological and habitat data for each station were collected on a single day. Water quality samples were collected in groups due to logistal restraints of the water quality laboratory.

STREAM NARRATIVES

Bedrock Creek

Bedrock Creek is approximately 14.5 km long, the lower 4.8 km of which flows within the Nez Perce Reservation. The stream flows in a southeasterly direction and discharges into the mainstem Clearwater River at river kilometer (rk) 32.2. Two major drainages contribute to this stream; Louse Creek, which is 8.4 kilometers long, provides the majority of flow during the summer months, and upper Bedrock Creek, which is 7.4 kilometers in length. The two streams converge to form mainstem Bedrock Creek, which flows for 4.8 kilometers to the mouth. Both upper Bedrock and Louse Creeks arise in agricultural environments with limited watershed capacity and flow through steep canyon terrain to their confluence. Louse Creek is relatively inaccessible and its steep slopes provide limited grazing. However, the upper Bedrock Creek canyon widens approximately 2.4 kilometers above the confluence with Louse Creek and provides relatively good access for grazing. The riparian zones on these two creeks reflect this differential grazing pressure. Approximately 0.9 kilometers below the confluence, the canyon narrows, limiting access, and has a well developed riparian zone. The last 2.4 kilometers above the mouth the stream is braided and has been heavily grazed with poor riparian habitat'. Signs of past flooding indicate that the stream channel in this section is not adequate to contain high flows. Logging has occurred in the past throughout the basin and many old logging roads remain in various states of disrepair. South and east facing slopes are heavily grazed and support few trees. High runoff following precipitation is a problem in this drainage. Water quality conditions found during low flow in 1982 and 1983 reflect near neutral conditions and indicate no limiting factors to salmonid production (Table 3).

Two stations were established on Bedrock Creek: station #l, located at stream kilometer (SK) 2.4 was sampled in 1982; and station #2, located at SK 6.4, was sampled in 1983.

Station #l

Species present include rainbow-steelhead trout, speckled dace, Paiute sculpin, bridgelip sucker, largescale sucker and redside shiner. The standing crop and density of overyearling rainbow-steelhead trout were 35.6 kg/ha and 0.2 fish/m2, respectively. Estimates for subyearling rainbow were 23.1 kg/ha and 1.6 fish/m2, respectively (Table 4).

Late summer stream flow was taken on July 8 and was 0.20 m3/sec. However, due to the heavy sampling schedule, actual low flow was not measured and would be less. Annual stream flow variation was extreme. Maximum water temperature was 20 C, approaching the lethal limits for salmonids. Little instream cover for overyearling rainbow-steelhead was identified at this station, 4% of the total area measured. Bank erosion was 15%. The average water velocity was 26 cm/sec, within the optimum range found by Bovee (1978). Average stream width was 3.79 m. Mean water depth was 18 cm, shallower than the optimum range found by Bovee (1978). Cobble embeddedness was approximately 25%, a point at which Bjornn et al (1978) indicates salmonid production can decline.

The major substrate type was gravel, which was smaller than the optimum sizes identified by Bovee (1978). Periphyton coverage was 50%, indicating good productivity. Pool riffle ratio was 30:70, indicating limited holding area for juvenile steelhead. In general, the channel integrity is poor due to inadequate bank structure for the present flow regime (Table 5).

Station #2

The upper reaches of the system support rainbow-steelhead trout, speckled dace, paiute sculpin and bridgelip sucker. Estimates of standing crop and density for overyearling rainbow-steelhead were 35.6 kg/ha and 0.6 fish/m2, respectively. Estimates for subyearling rainbow-steelhead were 3.9 kg/ha and 0.2 fish/m2, respectively (Table 4).

Late summer stream flow was 0.05 m3/sec. Annua 1 stream flow variation is extreme. Maximum water temperature was 16 C well below lethal limits for salmonids. Instream cover was 19% of the total area. No seriously eroding banks were seen, 0%. Water velocity was 10 cm/sec, slower than the optimum velocities identified by Bovee (1978). Mean water depth was 15 cm, shallower than the optimum values identified by Bovee (1978). Cobble embeddedness was 25%, which can limit salmonid production

(Bjornn et al 1977). The major substrate type was small rubble, which is among the optimum sizes for rainbow-steelhead juveniles (Bovee 1978). Periphyton coverage was l00%, indicating good productivity. The pool riffle ratio of 33:67 indicated almost twice as much riffle as pool area. Channel integrity was good, in general, due to cobble and small boulders established in the stream banks (Table 5).

Table 3. Water sample analysis from two stations on Bedrock Creek, tributary of lower Clearwater River Basin, Idaho, 1982, 1983.

Constituent	Station 1 Value	Station 2 Value
Calcium, Ca, mg/l	17.16	14.14
Magnesium, Mg, mg/l	7.35	5.41
Sodium, Na, mg/l	6.29	7.98
Potassium, K, mg/l	2.70	2.84
Chloride, Cl, mg/l	0.06	0.04
Carbonate, CO_3, mg/l	<0.22	0.08
Bicarbonate, HCO_3, mg/l	1.85	1.10
Sulfate, SO_4, mg/l	1.2	1.0
Nitrate, NO_3, mg/l	0.04	0.29
Orthophosphate, PO_4, mg/l	0.09	0.09
Total Residue, mg/l	126.0	148
Non-Filtered Residue, mg/l	1.8	<l
pH	7.8	7.8

Table 4. Fish population statistics for rainbow-steelhead trout on Bedrock Creek, tributary of lower Clearwater River Basin, Idaho, 1982, 1983.

Biological Parameter	Units	Station 1 Value	Station 2 Value
Age 0+ Rainbow-Steelhead			
Density	fish/m^2	1.6	.2
Standing Crop	kg/ha	23.1	3.9
Mean Weight	gm	1.5	1.6
Mean Length (TL-FL)	mm	NA	56-54
Age 1+ Rainbow-Steelhead			
Density	fish/m^2	0.2	0.6
Standing Crop	kg/ha	35.6	35.6
Mean Weight	gm	25.0	14.7
Mean Length (TL-FL)	mm	NA-129	122-113

Table 5. Measured physical parameters from two stations on Bedrock Creek, tributary of lower Clearwater River Basin, Idaho, 1982, 1983.

Physical Parameter	Station 1 Value	Station 2 Value
Late Summer Stream Flow (m^3/sec)	0.20	0.05
Annual Stream Flow Variation	Extreme	Extreme
Maximum Summer Temp. (C)	20	16
Instream Cover (%)	4	19
Eroding Banks (% of banks)	15	0
Water Velocity (cm/sec)	26	10
Stream Width (m)	3.79	3.72
Stream Depth (cm)	18	15
Cobble Embeddedness (%)	25	25
Major Substrate Type	Loose Gravel	Small Rubble
Periphyton Coverage (%)	50	100
Pool Riffle Ratio	30:70	33:66

Big Creek

Big Creek is approximately 10.5 kilometers in length, the lower 5.6 kilometers of which flows within the Nez Perce Reservation. The creek flows in a southwesterly direction and enters the Clearwater River at RK 59.2. Tributaries to Big Creek are small, numerous, and generally unnamed. The creek arises in farmland west of Weippe, Idaho and quickly drops into steep canyon terrain for the remainder of its length. Accessibility is extremely limited, except at the origin and the mouth. Cattle grazing occurs over most of the stream bottom, but is accentuated near the mouth and a wide area in the canyon at SK 4.8. The predominance of large and small boulders indicate extreme high annual flows. As in most of these canyons, the south and east facing slopes exhibit a lack of vegetation, which increases the rate of runoff. Riparian vegetation was good the entire length of stream, except in those areas where heavy grazing occurs. No chemical limitations to salmonid production were identified by the water quality analysis (Table 6).

One station was established on Big Creek, near SK 0.40. Low summer flow is characterized by an intermittent aquatic habitat in the upper reaches during the summer of 1983.

Rainbow-steelhead and paiute sculpin co-exist in Big Creek. Overyearling rainbow standing crop and density were 26.7 kg/ha and 0.08 fish/m2, respectively, but only one subyearling rainbow trout was captured (Table 7).

Late summer water flow was 0.05 m3/sec, with extreme annual variation. Maximum summer water temperature was 15.6 C, which is below lethal limits for trout. Overyearling rainbow-steelhead cover was 21% of the total stream area. No eroding banks were observed. Water velocity was 9 cm/sec, lower than optimum for rainbow-steelhead juveniles (Bovee 1978). Average stream width was 3.2 m at low flow. Mean water depth was 18 cm, which is shallower than the optimum estimated by Bovee (1978) for these fish. Cobble embeddedness was 50%, indicating probable limitations to salmonid production (Bjornn et al 1977). Large rubble was found to be the most common substrate type, this size was found optimal for juvenile rainbow-steelhead (Bovee 1978). Periphyton coverage was l00%, indicating excellent productivity. The pool riffle ratio was 70:30, providing good invertebrate production and abundant cover for overyearling steelhead. The banks were very stable, as they had been scoured in the past to a cobble-boulder marl (Table 8).

Table 6. Water sample analysis from one station on Big Creek, tributary of lower Clearwater River Basin, Idaho, 1983.

Constituent	Station 1 Value
Calcium, Ca, mg/1	0.76
Magnesium, Mg, mg/1	0.55
Sodium, Na, mg/1	0.29
Potassium, K, mg/1	0.06
Chloride, Cl, mg/1	0.07
Carbonate, C03, mg/1	0
Bicarbonate, HC03, mg/1	1.14
Sulfate, S04, mg/1	3.0
Nitrate, N03, mg/1	2.04
Orthophosphate, P04, mg/1	0.07
Total Residue, mg/1	130
Non-Filtered Residue, mg/1	4
PH	7.8

Table 7. Fish population statistics for rainbow-steelhead trout on Big Creek, tributary of lower Clearwater River Basin, Idaho, 1982, 1983.

Biological Parameter	Units	Station 1 Value
Age 0+ Rainbow-Steelhead		
Density	fish/m^2	0
Standing Crop	kg/ha	0
Mean Weight	gm	0
Mean Length (TL-FL)	mm	0
Age 1+ Rainbow-Steelhead		
Density	fish/m^2	.08
Standing Crop	kg/ha	26.7
Mean Weight	gm	32.91
Mean Length (TL-FL)	mm	151-142

Table 8. Measured physical parameters from one station on Big Creek, tributary of lower Clearwater River Basin, Idaho, 1983.

Physical Parameter	Station 1 Value
Late Summer Stream Flow (m3/sec)	.05
Annual Stream Flow Variation	Extreme
Maximum Summer Temp. (C)	15.6
Instream Cover (%)	21
Eroding Banks (% of banks)	0
Water Velocity (cm/sec)	9
Stream Width (m)	3.2
Stream Depth (cm)	18
Cobble Embeddedness (%)	50
Major Substrate Type	Large Rubble
Periphyton Coverage (%)	100
Pool Riffle Ratio	70:30

Butcher Creek

Butcher Creek is about 19.1 kilometers long, 1.9 of which flows within the Nez Perce Reservation, The stream flows in a northeasterly direction and discharges into the South Fork of the Clearwater River at RK 11. Several small tributaries drain the watershed which is comprised mainly of agricultural land and wood lots. The stream flows through a moderately steep canyon from the town of Mt. Idaho to the mouth. Cattle grazing occurs over the entire length of the creek, but predominantly in the extreme upper and lower reaches. Riparian vegetation was sparse at the two extremities but dense in the canyon proper. High annual runoff was evident and indications of past flooding were identified in the lower reaches. Logging has occurred in the past throughout the drainage. Water quality parameters measured at summer flow indicate no chemical limitations to salmonid production (Table 9).

Three stations were established on Butcher Creek: station #l at SK 0.4, sampled during the summer 1982; station #2, at SK 7.1, sampled during the summer 1983; and station #3, at SK 18.7 also sampled during summer 1983.

Station #l

Species composition consisted of one juvenile chinook salmon, northern squawfish, redside shiner, bridgelip sucker, specked dace and sculpin. No rainbow-steelhead trout were captured (Table 10). Late summer stream flow was 0.07 m^3/sec. Annual stream flow variation is extreme and large sized substrate indicate that the lower reaches are susceptible to high rates of scouring. The maximum summer water temperature during low flow was 22.2 C, which can inhibit salmonid production. Cover for overyearling rainbow-steelhead was 5% of the total area measured. Bank erosion was 11% of the total bank length. Water velocity was 22 cm/sec, within the range of optimum values for overyearling rainbow-steelhead (Bovee 1978). Stream width was 3.11 meters at low flow. Mean water depth was 10 cm, which was below optimum for overyearling rainbow-steelhead (Bovee 1978). Cobble embeddedness was 60%, which can severely limit salmonid production (Bjornn et al 1977). The major substrate type was small rubble, a substrate found optimum by Bovee (1978) for these fish. Periphyton coverage was 60%, indicating good productivity. The pool riffle ratio of l0:90 indicates large riffle areas which would benefit invertebrate production but limit habitat for overyearling steelhead trout. Channel integrity was relatively stable, as the banks had been scoured to rubble and small boulders in the past (Table 11).

Station #2

Only speckled dace and rainbow-steelhead trout were captured at this station. The estimated standing crop of overyearling rainbow-steelhead trout was 23.1 kg/ha, with a density of 0.06 fish/m2. No subyearling rainbow-steelhead were captured (Table 10).

Late summer stream flow was calculated to be 0.06 m3/sec, with moderate annual variation in flow. The maximum water temperature during low flow was 16.7 C, well within the lethal limit of salmonids. Instream cover was 11% of the total area surveyed and eroding banks were 29% of the total length. The mean water velocity was 16 cm/sec, near optimum for juvenile rainbow-steelhead (Bovee 1978). The average stream width was 2.19 m during the low flow. Mean stream depth was 5 cm, a depth which Bovee (1978) identified to be less than optimal. Cobble embeddedness was 25%, which could be limiting to salmonid production (Bjornn et al 1977). The major substrate was large rubble which was identified by Bovee (1978) as optimal for rainbow-steelhead juveniles. Periphyton coverage was 80%, indicated good productivity. The pool riffle ratio of 10:90 indicates a lack of holding area for overyearling rainbow-steelhead. The general stability of the channel and the stream banks was fair (Table 11).

Station #3

Rainbow-steelhead and speckled dace were captured at this station. The estimated standing crop of overyearling rainbow-steelhead was 2.0 kg/ha, with a density of 0.01 fish/m2. No subyearling rainbow-steelhead were captured (Table 10).

The late summer stream flow was 0.06 m3/sec, with moderate variation in annual flow. The maximum stream temperature was 20.5 C, approaching the maximum lethal limit for salmonid production. Instream cover for overyearling rainbow-steelhead was 4% and 44% of the toal stream banks showed signs of erosion.

Mean water velocity was 32 cm/sec, an optimum velocity for juvenile rainbow-steelhead (Bovee 1978). The mean stream width at low flow was 1.88 m. Mean stream depth was 11 cm, which is below optimum for these fish (Bovee 1978). Cobble embeddedness was 25%, which should'not limit salmonid production (Bjornn et al 1977). The major substrate identified was small rubble, which is near optimum for juvenile rainbow-steelhead (Bovee 1978). Periphyton coverage was 508, indicating good productivity. The pool riffle of 20:80 indicates a lack of holding area for overyearling steelhead trout. The overall bank and stream channel stability was good in the upper reaches of the stream (Table 11).

Table 9. Water sample analysis from three stations on Butcher Creek, tributary of S.F. Clearwater River Basin, Idaho, 1982, 1983.

Constituent	Station 1 Value	Station 2 Value	Station 3 Value
Calcium, Ca, mg/l	18.5	18.52	9.50
Magnesium, Mg, mg/l	8.6	7.25	3.30
Sodium, Na, mg/l	9.7	11.91	3.31
Potassium, K, mg/l	3.9	3.98	1.65
Chloride, Cl, mg/l	0.05	0.09	0.16
Carbonate, C03, mg/l	<0.22	0.33	NIL
Bicarbonate, HC03, mg/l	2.07	1.38	1.14
Sulfate, S04, mg/l	2.4	2	3
Nitrate, N03, mg/l	0.18	0.14	0.01
Orthophosphate, P04, mg/l	0.12	0.11	0.12
Total Residue, mg/l	236.6	250	124
Non-Filtered Residue, mg/l	21.2	3	18
pH	7.4	7.76	8.08

Table 10. Fish population statistics for rainbow-steelhead trout on Butcher Creek, tributary of S.F. Clearwater River Basin, Idaho, 1982, 1983.

Biological Parameter	Units	Station 1 Value	Station 2 Value	Station 3 Value
Age 0+ Rainbow-Steelhead				
Density	fish/m^2	0	0	0
Standing Crop	kg/ha	0	0	0
Mean Weight	gm	0	0	0
Mean Length (TL-FL)	mm	0	0	0
Age 1+ Rainbow-Steelhead				
Density	fish/m^2	0	0.06	0.01
Standing Crop	kg/ha	0	23.1	2.0
Mean Weight	gm	0	37	22
Mean Length (TL-FL)	mm	0	55-146	122-115

Table 11. Measured physical parameters from three stations on Butcher Creek, tributary of S.F. Clearwater River Basin, Idaho, 1982, 1983.

Physical Parameter	Station 1 Value	Station 2 Value	Station 3 Value
Late Summer Stream Flow (m3/sec)	0.07	0.06	0.06
Annual Stream Flow Variation	Extreme	Moderate	Moderate
Maximum Summer Temp. (C)	22.2	16.7	20.5
Instream Cover (%)	5	11	4
Eroding Banks (% of banks)	11	29	44
Water Velocity (cm/sec)	22	16	32
Stream Width (m)	3.11	2.19	1.88
Stream Depth (cm)	10	15	11
Cobble Embeddedness (%)	60	25	25
Major Substrate Type	Small Rubble	Small Rubble	Small Rubble
Periphyton Coverage (%)	60	80	50
Pool Riffle Ratio	10:90	10:90	20:80

Catholic Creek

Catholic Creek is approximately 16.1 kilometers long, of which 14.5 kilometers are within the Nez Perce Reservation. The stream arises in farmland east of Genesee, Idaho and flows southeasterly for 9.7 kilometers through a moderately steep walled canyon to its confluence with the Clearwater River at RK 18.5. The lower two miles of the canyon is relatively wide and is utilized for various ranching activities. Riparian vegetation is scarse in the upper and lower reaches of the creek where agricultural activities are most intense, but relatively dense in the canyon reach. Approximately 0.4 KM upstream from the mouth the stream flows through a cattle feed lot which is used during the winter months. Water quality analysis indicated no chemical limitations to salmonid production (Table 12).

Two stations were established on Catholic Creek: station #l at SK 0.40 and station #2 at SK 1.9, both sampled during summer 1983.

Station #l

Speckled dace, redside shiner and rainbow-steelhead trout were captured at station #l. One subyearling steelhead was found but a population estimate was not made. Overyearling steelhead standing crop and density were 13.3 kg/ha and 0.03 fish/m2, respectively (Table 13).

Late summer stream flow was 0.08 m3/sec, with a moderate annual variation. Occasional flooding has occurred, although it doesn't seem to be a perennial occurrence. Maximum water temperature was 20 C, which is approaching the upper lethal limits for salmonids. Instream cover for rainbow-steelhead juveniles was 45% of the total area surveyed. This cover was mostly annual grasses, which would be absent during the winter months. Forty percent of the stream banks were eroding, indicating an unstable enviornment Mean water velocity was 25 cm/sec, which is within the optimum range for steelhead juveniles (Bovee 1978). The stream width was 2.7 m at low summer flow. Mean water depth was 11 cm, below the optimum range for steelhead juveniles (Bovee 1978). Cobble embeddedness was 253, a value approaching a point which could limit salmonid production (Bjornn et al 1977). The major substrate type was small rubble, which is within the optimum size range for rainbow-steelhead juveniles (Bovee 1978). Periphyton coverage was 603, indicating good productivity. The pool riffle ratio was 10:90, revealing a lack of holding area for juvenile steelhead. Channel stability was poor, as the banks consisted of gravel and sand (Table 14).

Station #2

Rainbow-steelhead trout and speckled dace were the only species captured at this station. Standing crop and density **estimates** for overyearling rainbow-steelhead were 6.2 kg/ha and 0.01 fish/ha, respectively. Subyearling estimates were 0.29 kg/ha and 0.7 fish/m2, resepctively (Table 13).

Late summer flow was 0.05 m3/sec, with moderate annual variation.

Maximum water temperature during low flow was 15.5 C, within the lethal limits to salmonid production. Three percent of the total area surveyed contained cover suitable to juvenile steelhead. Mean stream width was 2.3 m at low summer stream flow. Average stream depth was 28 cm, which is close to optimum for juvenile steelhead rearing (Bovee 1978). Cobble embeddedness was 15%, which is probably not limiting to salmonid production (Bjornn et al 1977). The major substrate type was small rubble, which is among the optimum sizes for juvenile rainbow-steelhead identified by Bovee (1978). Periphyton covered 80% of the substrate, indicating good productivity. The pool riffle ratio was 10:90, and does not provide adequate cover for juvenile steelhead. Channel integrity was not good at this location (Table 14).

Table 12. Water sample analysis from two stations on Catholic Creek, tributary of lower Clearwater River Basin, Idaho, 1983.

Constituent	Station 1 Value	Station 2 Value
Calcium, Ca, mg/1	31.16	31.35
Magnesium, Mg, mg/l	11.67	11.61
Sodium, Na, mg/l	16.92	17.48
Potassium, K, mg/l	3.73	3.26
Chloride, Cl, mg/l	0.07	0.07
Carbonate, C03, mg/l	0.33	0.24
Bicarbonate, HC03, mg/l	2.60	2.65
Sulfate, S04, mg/l	2.0	3.0
Nitrate, N03, mg/l	0.84	0.97
Orthophosphate, P04, mg/l	0.25	0.22
Total Residue, mg/l	248	214
Non-Filtered Residue, mg/l	34	7
PH	8.3	8.7

Table 13. Fish population statistics for rainbow-steelhead trout on Catholic Creek, tributary of lower Clearwater River Basin, Idaho, 1982.

Biological Parameter	Units	Station 1 Value	Station 2 Value
Age 0+ Rainbow-Steelhead			
Density	fish/m^2	0	8.7
Standing Crop	kg/ha	0	.29
Mean Weight	gm	0	4
Mean Length (TL-FL)	mm	0	77-74
Age 1+ Rainbow-Steelhead			
Density	fish/m^2	0.03	0.01
Standing Crop	kg/ha	13.3	6.2
Mean Weight	gm	43.6	43.5
Mean Length (TL-FL)	mm	155-147	170-158

Table 14, Measured physical parameters from two stations on Catholic Creek, tributary of lower Clearwater River Basin, Idaho, 1983.

Physical Parameter	Station 1 Value	Station 2 Value
Late Summer Stream Flow (m3/sec)	.08	.05
Annual Stream Flow Variation	Extreme	Extreme
Maximum Summer Temp. (C)	20	15.5
Instream Cover (%)	45	3
Eroding Banks (% of banks)	40	42
Water Velocity (cm/sec)	25	22
Stream Width (m)	2.7	2.34
Stream Depth (cm)	11	28
Cobble Embeddedness (%)	25	15
Major Substrate Type	Small Rubble	Small Rubble
Periphyton Coverage (%)	60	80
Pool Riffle Ratio	10:90	10:90

Corral Creek

Corral Creek is a small, south flowing tributary of the mainstem Clearwater River, located west of Kamiah, Idaho, and is not named on area maps. The stream arises in farmland wood lot habitat. Two major forks, one flowing through Idaho State land and the other through Nez Perce Tribal land, converge and flow approximately 1.6 kilometers to the Clearwater River. Access to the lower stream is through private land or railroad easement. Riparian overstory is present throughout the drainage although understory is lacking in the lower reaches due to high spring runoff. Water quality analysis indicate no limiting factors to salmonid production (Table 15). One station was established at SK 1.2 during summer 1983.

The standing crop estimate for overyearling rainbow was 5.2 kg/ha, with a density of 0.03 fish/m2. One underyearling rainbow was captured. Sculpins and speckled dace were plentiful at this station (Table 16).

Late summer stream flow was 0.04 m3/sec, and annual stream flow variation is moderate with indications of some past flooding. The maximum summer water temperature was 20 C, which is approaching lethal limits for salmonids. Instream cover for overyearling rainbow-steelhead trout was 12% of the total stream area. No eroding banks were identified. Average water velocity was 12 cm/sec, a value found to be near optimum for rainbow-steelhead juveniles (Bovee 1978). Mean stream width was 2.68 meters at low flow. Mean water depth was 13 cm, which is shallower than optimal for rainbow-steelhead juveniles (Bovee 1978). Cobble embeddedness was zero, indicating negligable sedimentation. The major substrate was small rubble, which is optimal for juvenile rainbow-steelhead trout (Bovee 1978). Periphyton coverage was rated 100% indicating good productivity. The pool riffle ratio was 30:70, indicated a lack of pool habitat for steelhead. The stream channel was relatively stable due to banks consisting of large cobble, small boulders, and organic debris (Table 17).

Table 15. Water sample analysis from one station on Corral Creek, tributary of lower Clearwater River Basin, Idaho, 1983.

Constituent	Station 1 Value
Calcium, Ca, mg/1	0.88
Magnesium, Mg, mg/1	0.52
Sodium, Na, mg/1	0.34
Potassium, K, mg/1	0.10
Chloride, Cl, mg/1	0.11
Carbonate, CO3, mg/1	0
Bicarbonate, HCO3, mg/1	1.43
Sulfate, SO4, mg/1	2.0
Nitrate, NO3, mg/1	0.64
Orthophosphate, PO4, mg/1	0.07
Total Residue, mg/1	114
Non-Filtered Residue, mg/1	22
PH	8.1

Table 16. Fish population statistics for rainbow-steelhead trout on Corral Creek, tributary of lower Clearwater River Basin, Idaho, 1983.

Biological Parameter	Units	Station 1 Value
Age 0+ Rainbow-Steelhead		
Density	fish/m^2	0
Standing Crop	kg/ha	0
Mean Weight	gm	0
Mean Length (TL-FL)	mm	0
Age 1+ Rainbow-Steelhead		
Density	fish/m^2	.03
Standing Crop	kg/ha	5.2
Mean Weight	gm	20.9
Mean Length (TL-FL)	mm	136-129

Table 17. Measured physical parameters from one station on Corral Creek, tributary of lower Clearwater River Basin, Idaho, 1983.

Physical Parameter	Station 1 Value
Late Summer Stream Flow (m^3/sec)	0.04
Annual Stream Flow Variation	Moderate
Maximum Summer Temp. (C)	20
Instream Cover (%)	12
Eroding Banks (% of banks)	0
Water Velocity (cm/sec)	12
Stream Width (m)	2.68
Stream Depth (cm)	13
Cobble Embeddedness (%)	0
Major Substrate Type	Small Rubble
Periphyton Coverage	100%
Pool Riffle Ratio	30:70

Cottonwood Creek

Cottonwood Creek (Idaho County) is 25.7 kilometers long and originates near Cottonwood, Idaho on the Camas prairie. The stream flows easterly and enters the South Fork of the Clearwater River at RK 9.7. The major tributaries are Redrock Creek, Shebang Creek, and South Fork Cottonwood Creek. Constant flow during August was identified beginning about 12.9 kilometers east of Cottonwood,Idaho. Heavy farming and grazing has taken place on these tributaries resulting in a severe lack of riparian vegetation and bank erosion. The majority of these tributaries receive heavy silt deposition. From the point identified with summer flow, the stream begins to descend through additional pasture land, which has better developed riparian areas and slightly less silt deposition. The stream then plunges into a steep bouldered canyon, dominated by deep pools. The riparian zone improves as the stream enters the canyon. Approximately 1.2 kilometers upstream from the lower end of this canyon is a sheer 9.1 meter falls (SK) precluding upstream movement of any fish. Below this canyon the stream flows into a heavily grazed, open, flat bottomed basin. From this point to the confluence with the South Fork Clearwater River, the channel is braided and/or channelized. Riparian vegetation is lacking throughout the lower system. Water quality analysis indicates no chemical limitations to salmonid production (Table 18).

Two stations were established on Cottonwood Creek: station #l was located at SK 1.6 and station #2, located at SK 9.6.

Station #l

Redside shiners, speckled dace, sculpin, bridgelip sucker, northern squawfish and chiselmouth were found and no salmonids were captured at this 'location (Table 19).

Late summer flow was 0.7 m3/sec and signs indicated extreme annual variation in flow and frequent flooding. Maximum summer water temperature was 21.1 c, which can limit salmonid production. Twelve percent of the total area surveyed provided cover for juvenile rainbow-steelhead. All of the banks were eroding, adding silt to the system. Mean water velocity was 52 cm/sec, an optimum value for juvenile rainbow-steelhead (Bovee 1978). Stream width was 10.1 m at low summer flow. Mean stream depth was 14 cm, sahllower than optimum for rainbow-steelhead juveniles (Bovee 1978). Cobble embeddedness was 25%, probably not limiting to salmonid production (Bjornn et al 1977). The major substrate was large cobble, a size optimum for juvenile rainbow-steelhead (Bovee 1978). Periphyton covered 90% of the substrate, indicating good productivity. The pool riffle ratio of 0:lOO indicated a severe lack of pool habitat and holding areas for overyearling rainbow-steelhead. The stream channel stability in this area was very poor (Table 20).

Station #2

No salmonids were capturedat this station,however redside shiners were abundant (Table 19).

The late summer stream flow was 0.22 m3/sec and annual flow variation was moderate with occasional flooding, as seen by the dry side channels. Maximum water temperature was 16.1 C, well within the lethal limits for salmonid fishes. Instream cover for juvenile rainbow-steel'head was identified as 6% of the area surveyed. Practically all of the stream banks were eroding, indicating a significant source of sedimentation. Mean water velocity was 25 cm/sec, below the optimum for rainbow-steelhead juveniles (Bovee 1978). Average stream width was 4.7 m at low summer stream flow. Mean water depth was 22 cm, below the optimum for juvenile rainbow-steelhead (Bovee 1978). Cobble embeddedness was 258, which should not limit salmonid production (Bjornn et al 1977). The major substrate was small boulder,which is an optimum size for rainbow-steelhead juveniles (Bovee 1978). Periphyton coverage was lOO%, indicating good productivity. The pool riffle ratio was 30:70, indicating a lack of pool habitat. Stream channel stability in this area was poor due to a bank composition of loose soil with intermittent boulders (Table 20).

Table 18. Water sample analysis from three stations on Cottonwood Creek, tributary of S.F. Clearwater River Basin, Idaho, 1982, 1983.

Constituent	Station 1 Value	Station 2 Value
Calcium, Ca, mg/l	32.11	31.21
Magnesium, Mg, mg/l	11.82	10.97
Sodium, Na, mg/l	22.66	23.91
Potassium, K, mg/l	3.54	3.74
Chloride, Cl, mg/l	0.24	0.21
Carbonate, C03, mg/l	0.49	0.57
Bicarbonate, HC03, mg/l	3.17	1.67
Sulfate, S04, mg/l	4.0	4.0
Nitrate, N03, mg/1	0.01	0.71
Orthophosphate, P04, mg/l	0.36	0.29
Total Residue, mg/l	230	256
Non-Filtered Residue, mg/l	45	52
pH	8.4	8.4

Table 19. Fish population statistics for rainbow-steelhead trout on Cottonwood Creek, tributary of S.F. Clearwater River Basin Idaho, 1983.

Biological Parameter	Units	Station 1 Value	Station 2 Value
Age 0+ Rainbow-Steelhead			
Density	fish/m^2	0	0
Standing Crop	kg/ha	0	0
Mean Weight	gm	0	0
Mean Length (TL-FL)	mm	0	0
Age 1+ Rainbow-Steelhead			
Density	fish/m^2	0	0
Standing Crop	kg/ha	0	0
Mean Weight	gm	0	0
Mean Length (TL-FL)	mm	0	0

Table 20. Measured physical parameters from two stations on Cottonwood Creek, tributary of S.F. Clearwater River Basin, Idaho, 1983.

Physical Parameter	Station 1 Value	Station 2 Value
Late Summer Stream Flow (m3/sec)	0.70	0.22
Annual Stream Flow Variation	Extreme	Moderate
Maximum Summer Temp. (C)	21.1	16.1
Instream Cover (%)	12	6
Eroding Banks (% of banks)	100	83
Water Velocity (cm/sec)	52	25
Stream Width (m)	10.1	4.7
Stream Depth (cm)	14	22
Cobble Embeddedness (%)	25	25
Major Substrate Type	Large Cobble	Small Boulder
Periphyton Coverage (%)	90	100
Pool Riffle Ratio	0:100	30:70

Jim Ford Creek

Jim Ford Creek flows for 38.6 kilometers, the lower 5.15 kilometers flow through the Nez Perce Reservation. The stream flows southwesterly and enters the mainstem Clearwater River at RK 54.9. The stream originates northeast of Weippe, Idaho. The watershed consists of many intermittent tributaries with minimal riparian vegetation. Major tributaries of Jim Ford Creek are Meadow Creek, Snake Meadow Creek, Winter Creek, and Grasshopper Creek. From Weippe, the stream drops into a very steep canyon with very little access for approximately six miles. It then plunges over a sheer, 19.8 m falls, preventing any upstream migration. From this point to the mouth, the canyon broadens and is used for light grazing activity. Side channels and large substrate indicate yearly flooding. The riparian zone does not generally shade the stream at low flow due to the shallow, wide nature of the stream. Heavy periphyton growth was observed in the lower section of the stream, which may indicate organic pollution. The stream also has bacterial, turbidity, and iron levels which were found to exceed recommended criteria (Idaho Dept. of Health and Welfare 1980b). The city of Weippe and Timberline High School both discharge effluent into the drainage (Kucera et al 1983). Water quality analysis indicated no limiting factors to salmonid production (Table 21).

Two stations were established on Jim Ford Creek below the falls: station #l, located at SK 1.3 was surveyed during summer 1982;

and station #2, located at SK 17.7 was surveyed during the summer of 1983.

Station #l

Fish population surveys showed the presence of rainbow-steelhead trout, smallmouth bass, northern squawfish, chiselmouth, bridgelip sucker, sculpin and dace. Standing crop of overyearling rainbow-steelhead was 3.5 kg/ha, with a density of 0.02 fish/ha. Subyearling steelhead were captured in small numbers but not included in the calculations (Table 22).

Late summer stream flow was 0.4 m3/sec, with moderate variation in annual flow. Maximum water temperature was 27.8 C, which exceeds the lethal limits for trout production. Instream cover was 8% of the area surveyed. Eroding banks were minimal, with only 7.8% affected. Mean water velocity was 22.1 cm/sec, which is slightly lower than optimum for juvenile rainbow-steelhead (Bovee 1978). Stream width was 6.9 m at low flow. Stream depth averaged 23 cm, which is slightly lower than that most preferred by juvenile rainbow-steelhead (Bovee 1978). Cobble embeddedness was 40%, which may limit salmonid production (Bjornn et al 1977). The major substrate was large rubble, which is among the most preferred by juvenile steelhead (Bjornn et al 1977). The periphyton coverage of 80% indicated good primary production. The pool riffle ratio of 30:70 indicated some limited pool habitat and a majority of riffle area which are not condusive to juvenile steelhead rearing. Stream banks in this section were moderately stable and held together by large cobble and boulder (Table 23).

Station #2

Longnose dace, speckled dace and both are groups of rainbow-steelhead were captured at station #2. Estimated standing crop of overyearling rainbow-steelhead was 21.8 kg/ha, with a density of 0.07 fish/m2. Estimated subyearling standing crop was 9.6 kg/ha, with a density of 0.43 fish/m2 (Table 22).

Late summer stream flow was 0.3 m3/sec, with moderate variation in annual stream flow. Maximum water temperature recorded during low flow was 16.1 C, which is within the lethal limits for salmonid production. Thirty percent of the total stream area provided cover for juvenile rainbow-steelhead. No eroding stream banks were observed. Mean water velocity was 25 cm/sec, within the optimum range for juvenile steelhead trout (Bovee 1978). Stream width was 7.9 m at low flow. Average stream depth was 13 cm, which is below the optimum range for juvenile rainbow-steelhead (Bovee 1978). Cobble embeddedness was 0%, indicating no limitations to salmonid production by sedimentation (Bjornn et al 1977). The major substrate was a combination of small boulder and large cobble which is within the optimum size range for juvenile steelhead trout (Bovee 1978). Periphyton coverage was 100%, indicating good productivity. The pool riffle ratio was 5:95, which indicated a lack of suitable pool habitat for juvenile rainbow-steelhead. Stream channel integrity was good at low flow, although at high flow the banks are unstable due to an abundance of loose soil with little infrastructure (Table 23).

Table 21. Water sample analysis from one station on Jim Ford Creek, tributary of lower Clearwater River Basin, Idaho, 1982.

Constituent	Station 1 Value	Station 2 Value
Calcium, Ca, mg/1	10.6	8.8
Magnesium, Mg, mg/1	4.2	3.5
Sodium, Na, mg/1	5.2	5.2
Potassium, K, mg/1	2.2	2.2
Chloride, Cl, mg/1	<0.01	0.04
Carbonate, CO3, mg/1	<0.22	0
Bicarbonate, HCO3, mg/1	2.98	0.73
Sulfate, SO4, mg/1	2.6	1.0
Nitrate, NO3, mg/1	0.15	0.05
Orthophosphate, PO4, mg/1	0.16	<0.01
Total Residue, mg/1	206	152
Non-Filtered Residue, mg/1	6	<1
pH	7.5	8.1

Table 22. Fish population statistics for rainbow-steelhead trout on Jim Ford Creek, tributary of lower Clearwater River Basin, Idaho, 1983.

Biological Parameter	Units	Station 1 Value	Station 2 Value
Age 0+ Rainbow-Steelhead			
Density	fish/m^2	0	0.43
Standing Crop	kg/ha	0	9.6
Mean Weight	gm	0	2.23
Mean Length (TL-FL)	mm	0	64-61
Age 1+ Rainbow-Steelhead			
Density	fish/m^2	0.02	0.07
Standing Crop	kg/ha	3.5	21.8
Mean Weight	gm	22	32
Mean Length (TL-FL)	mm	NA-133	138-130

Table 23. Measured physical parameters from two stations on Jim Ford Creek, tributary of lower Clearwater River Basin, Idaho, 1983.

Physical Parameter	Station 1 Value	Station 2 Value
Late Summer Stream Flow (m3/sec)	0.4	0.3
Annual Stream Flow Variation	Moderate	Moderate
Maximum Summer Temp. (C)	27.8	16.1
Instream Cover (%)	8	30
Eroding Banks (% of banks)	7.8	0
Water Velocity (cm/sec)	22.1	25
Stream Width (m)	6.9	7.9
Stream Depth (cm)	23	13
Cobble Embeddedness (%)	40	0
Major Substrate Type	Large Rubble	Small Boulder
Periphyton Coverage (%)	80	100
Pool Riffle Ratio	30:70	5:95

Lawyers Creek

The following information is a description of the source of Lawyers Creek, not surveyed by Kucera et al (1983). The data collected at this station does not affect or modify the findings and recommendations of Kucera and will be reported here as an appendum.

The headwaters of Lawyers Creek, during summer low flow, was a spring located at SK 67.6. This water source is impounded adjacent to the spring proper and used for stock watering. Water overflowing from this pond forms Lawyers Creek. The stock pond has been planted with resident rainbow trout which have moved out of the pond and into the stream in the past. The stream flows through pastureland and riparian vegetation is lacking. Water quality analysis indicated no limiting factors to salmonid production (Table 24).

Speckled dace as well as rainbow trout were captured at this station. Estimated standing crop of overyearling rainbow trout was 91.0 kg/ha, with a density of 0.3 fish/m2. The estimated standing crop for subyearling rainbow trout was 0.7 kg/ha, with a density of 0.1 fish/m2 (Table 25).

Late summer stream flow was 0.01 m3/sec, with very little annual variation in flow. Maximum water temperature was 15.5 C, nearly optimal for salmonid production. Instream cover for juvenile rainbow-steelhead was 41% of the area surveyed. Forty percent of the total stream banks were eroding. Average water velocity was too low to record, which is well below the preferred range of rainbow-steelhead trout (Bovee 1978). Stream width during low flow averaged 2.0 m. Mean stream depth was 14 cm, below the optimum range for juvenile rainbow-steelhead (Bovee 1978). Cobble embeddedness was 508, indicating a siltation problem which could reduce salmonid production (Bjornn et al 1977). The major substrate was sand, which is below optimum for rainbow-steelhead juveniles (Bovee 1978). Periphyton covered 60% of the substrate, indicating good productivity. The pool riffle ratio was 80:20, indicating an abundance of juvenile steelhead cover but possibly limiting invertebrate production. In general, the stream channel is not stable. The top soil is about two feet deep and subject to erosion, accentuated by the lack of riparian vegetation (Table 26).

Table 24. Water sample analysis from one station on Lawyers Creek, tributary of lower Clearwater River Basin, Idaho, 1983.

Constituent	Station: Headwaters Value
Calcium, Ca, mg/1	14.50
Magnesium, Mg, mg/1	4.22
Sodium, Na, mg/1	5.22
Potassium, K, mg/1	2.25
Chloride, Cl, mg/1	0.09
Carbonate, CO3, mg/1	0.08
Bicarbonate, HCO3, mg/1	1.10
Sulfate, SO4, mg/1	2.0
Nitrate, NO3, mg/1	0.02
Orthophosphate, PO4, mg/1	0.05
Total Residue, mg/1	190
Non-Filtered Residue, mg/1	1.0
pH	7.72

Table 25. Fish population statistics for rainbow-steelhead trout on Lawyers Creek, Lower Clearwater River Basin, Idaho, 1983.

Biological Parameter	Units	Station 1 Value
Age 0+ Rainbow-Steelhead		
Density	fish/m^2	0.1
Standing Crop	kg/ha	0.7
Mean Weight	gm	1.0
Mean Length (TL-FL)	mm	53-52
Age 1+ Rainbow-Steelhead		
Density	fish/m^2	0.3
Standing Crop	kg/ha	91.0
Mean Weight	gm	27.15
Mean Length (TL-FL)	mm	140-133

Table 26. Measured physical parameters from one station on Lawyers Creek, tributary of Lower Clearwater River Basin, Idaho, 1983.

Physical Parameter	Station: Headwaters Value
Late Summer Stream Flow (m3/sec)	.01
Annual Stream Flow Variation	Small
Maximum Summer Temp. (C)	15.5
Instream Cover (%)	41
Eroding Banks (% of banks)	40
Water Velocity (cm/sec)	0
Stream Width (m)	2.0
Stream Depth (cm)	14
Cobble Embeddedness (%)	50
Major Substrate Type	Sand
Periphyton Coverage (%)	60
Pool Riffle Ratio	80:20

Lo10 Creek System

Lolo Creek is approximately 67.1 kilometers in length. The stream originates in the Clearwater National Forest, southeast of Weippe, Idaho, and flows westerly to its confluence with the Clearwater River near Greer, Idaho. The watershed includes approximately 196 kilometers of streams on and off the Clearwater National Forest. Major tributaries to Lolo Creek are Yakus, Eldorado, Musselshell, Browns, and Yoosa Creeks. The system is atypical, in respect to the other streams in this report. Differences include its large size, granitic watershed influence, diversity of habitat, and dominant affects of logging. In addition, Lo10 Creek has an elevation loss of 1200 meters, originating at 1597 meters and dropping to 396 meters at the confluence with the Clearwater River (Espinosa 1975).

Erosion from. road construction has been identified as the major contributor of sediment to the stream system (Espinosa 1975). Generally, roads follow portions of all streams at stream level or on directly adjacent slopes. In addition to the sedimentation originating from roads, several mining claims contribute to both sedimentation and degradation of stream channel integrity on upper Lolo Creek.

Lo10 Creek

Lolo Creek is approximately 67.1 kilometers in length, 37.6 kilometers of which are within the Clearwater National Forest. The stream within the forest can be characterized by granitic substrate, cedar, yellow pine, grand fir, hemlock forest, a willow alder riparian belt, and a medium gradient with intermittent cascades. Logging on this stream has occurred since the late 1930's (Space 1964). Both old deteriorating roads and well maintained roads parallel the entire stream channel. That portion of stream flowing from the forest boundary to the Clearwater River has a lower gradient and is influenced by deep canyon terrain and semi arid watershed. Sections of this canyon widen, which are occupied by small farms and provide possible salmonid spawning areas. Access to this region is difficult, and is restricted to a few deteriorating private roads. Water quality analysis did not identify any limiting factors to salmonid production (Tables 27a, 27b).

Seven stations were established on mainstem Lolo Creek: station #1, located at SK 0.8; station #2, located at SK 25.7 near a bridge crossing; station #3, located at SK 43.4, just below the National Forest boundary; station #4, located at SK 49.8, above the confluence of Musselshell Creek; stations #5 & #6, located in tandem, at SK 57.8 prior to instream improvements by forest service personnel; and station #7, located at SK 62.6 below the mouth of Yoosa Creek.

Station #l

Fish species composition included rainbow-steelhead trout, chinook salmon, smallmouth bass, northern squawfish, chiselmouth, redside shiner, long nose dace, speckled dace, sculpin, and possibly Pacific lamprey, (Entosthenus tritatus) ammocoetes. Insufficient numbers of individual fish species were collected to generate population estimates (Table 28a).

Late summer stream flow was 4.4 m^3/sec, with moderate annual variation in stream flow. The maximum water temperature during summer low flow was 21.7 C, approaching lethal limits for salmonid production. Instream cover for overyearling salmonids was 28% and bank erosion was 11.1% of the habitat measured. Mean water velocity was 65 cm/sec, above the optimum values for rainbow-steelhead juveniles (Bovee 1978). The average stream" width during summer low flow was 11.2 m. Mean water depth was 60 cm, deeper optimum values for rainbow-steelhead juveniles (Bovee 1978). Cobble embeddedness was 608, which can severely 1 imit salmonid production (Bjornn et al 1977).

The major substrate identified was large rubble, an optimum size for rainbow-steelhead juveniles (Bovee 1978). Periphyton coverage of the substrate was 50%, indicating moderate productivity. The estimated pool riffle ratio of 35:65 indicated a lack of pool habitat.,, In general, the stability of the lower Lolo Creek channel is very good due to large substrate, large, well established riparian vegetation, and a constricted canyon environment {Table 29a).

Station #2

Fish species observed included juvenile rainbow-steelhead trout, mountain whitefish, bridgelip suckers, longnose dace, speckled dace, and sculpins. One underyearling steelhead was seen and, due to the uneveness of the substrate which made counting of small fish difficult, a population count was not done. Overyear ling . steelhead density was 0.2 fish/m2 with a standing crop estimate of 3.20 kg/ha. Nineteen overyearling whitefish were counted at this station (Table 28a).

Late summer stream flow was 4.1 m3/sec, with moderate variation in annual stream flow. Maximum water temperature during summer low flow was 16 C, well below the lethal limits for salmonid production. Instream cover for juvenile salmonids was 26% of available habitat. There were no eroding stream banks. Mean water velocity was 65 cm/sec, slightly above the optimum values identified by Bovee (1978) . The average stream width was 11.8 m. Mean water depth was 53 cm, slightly above optimum values (Bovee 1978). Cobble embeddedness was 258, which approach levels which can limit salmonid production (Bjornn et al 1977). The major substrate was large rubble, an optimum size for juvenile rainbow-steelhead (Bovee 1978). Periphyton coverage was 40%, indicating moderate productivity. The pool riffle ratio 30:70 indicated a lack of pool habitat and‘holding areas for juvenile steelhead. General channel stability was good with the exception of fill associated with bridge construction (Table 29a) .

Station #3

Rainbow-steelhead trout and mountain whitefish were collected at this station. Subyearling rainbow-steelhead numbers were negligible. Standing crop of overyearling rainbow-steelhead was 0.62 kg/ha, with a density'of ,004 fish/m2 (Table 28a). Mountain whitefish was the dominant species in terms of biomass and numbers.

Late summer stream flow was 4.3 m3/sec, with moderate annual variation in flow. The maximum water temperature during low flow was 21 C, approaching the lethal limits for salmonid production. Instream cover for juvenile rainbow-steelhead was 8% of the total area surveyed. No bank erosion was identified in this area. Mean water velocity was 58 cm/sec, slightly above the optimum values determined by Bovee (1978). Average stream width was 18.7 m during low summer flow. Mean water depth was 49 cm, an optimum value for juvenile rainbow-steelhead (Bovee 1978). Cobble embeddedness was 758, which can be a limiting factor to salmonid production (Bjornn et al 1977). The major substrate identified was sand, a size considerably smaller than optimum for rainbow-steelhead (Bovee 1978). Periphyton coverage was l00%, indicating excellent productivity. The estimated pool riffle ratio was 30:70, indicating a lack of pool habitat. Stream channel stability was good, due to the presence of bedrock in the stream banks. Adjacent to the station, however, a widening of the canyon enabled peak flow to scour a small floodplain (Table 29a).

Station #4

Fish species collected included rainbow-steelhead trout, chinook salmon, and speckled dace. Standing crops of subyearling and overyearling rainbow-steelhead trout were 0.93 and 2.9 kg/ha, respectively, with densities of 0.03 and 0.2 fish/m2 (Table 28b). Standing crops of subyearling and overyearling chinook salmon were 3.1 and 12.2 kg/ha, respectively. Densities were 0.9 and 0.5 fish/m2 for subyearling and overyearling, respectively.

Late summer stream flow was 1.3 m3/sec, with moderate annual variation in stream flow. Maximum water temperature during low flow was 18 C. Instream cover for juvenile rainbow-steelhead was 21% of the available area. Bank erosion was 23% of stream bank surveyed. Mean water velocity was 85 cm/sec, well above optimum values (Bovee 1978). Average stream width during low summer flow was 6.9m. Mean water depth was 22 cm, slightly below the optimum values identified by Bovee (1978). Estimated cobble embeddedness was 20%, below levels which can inhibit salmonid production (Bjornn et al 1977). The major substrate was small rubble an optimum size for rainbow-steelhead juveniles (Bovee 1978). Periphyton coverage of the substrate was 100%, indicating excellent productivity. The pool riffle ratio was 40:60, indicating a lack of pool habitat. Stream channel integrity was good due to well established small and large woody riparian vegetation and large woody debris (Table 29b).

Station #5

Rainbow-steelhead trout was the only species observed at this station. Subyearling standing crop was 3.0 kg/ha, and overyearling standing crop was 22.2 kg/ha. Density estimates for subyearling and overyearling trout were 0.27 and 0.13 fish/m2, respectively (Table 28b).

Late summer stream flow was 1.3 m3/sec, with moderate annual variation in stream flow. The maximum water temperature during low summer stream flow was 14 c, below the lethal limits for salmonid production. Instream cover for juvenile rainbow-steelhead was 23% of the available area. Bank erosion was 6% of the banks surveyed. Mean water velocity was 46 cm/sec, an optimum value for juvenile rainbow-steelhead trout (Bovee 1978). The average stream width during the low flow period was 9.5 m. Mean water depth was 30 cm, an optimum depth for rainbow-steelhead trout (Bovee 1978). Cobble embeddedness was 15%, well below those values identified by Bjornn et al 1977, which limit salmonid production. The major substrate was large rubble, an optimum size for rainbow-steelhead trout (Bovee 1978). The estimated periphyton coverage of 100% indicated excellent productivity. The pool riffle ratio was 50:50, near optimum for salmonid fishes. The general stream channel integrity was good due to the presence of large substrate, woody debris, and well established riparian vegetation (Table 29b).

Station #6

Subyearling rainbow-steelhead trout were observed at this location but could not be quantified due to shallow depth and great width. In addition to trout, sculpins were moderately abundant at this station (Table 28b).

Late summer stream flow was 1.3 m3/sec, with moderate variation in annual stream flow. The maximum summer water temperature was 14 c. Instream cover was 7% of available area. Bank erosion was not identified at this station. Mean water velocity was 43 cm/sec, which was near optimum for juvenile rainbow-steelhead(Bovee 1978). Average stream width was 12.7 m. Mean water depth was 34 cm, an optimum value for rainbow-steelhead trout (Bovee 1978). Cobble embeddedness was 25%, close to a value which may limit the production of juvenile'salmonids (Bjornn et al 1977).The major substrate was small rubble,which is among the optimum sizes for juvenile steelhead (Bovee 1978). Coverage of the substrate by periphyton was l00%, indicating excellent productivity. The pool riffle ratio was 10:90, indicating a severe lack of pool habitat. The stream channel integrity was excellent due to good riparian habitat and well established overstory (Table 29b).

Station #7

Similar to station 6, subyearling rainbow-steelhead trout were observed at this location but were not quantified. In addition, overyearling rainbow-steelhead and rainbow-cutthroat hybrids were observed (Table 28b).

Late summer stream flow was 1.6 m3/sec, with a small annual variation in that flow. The maximum water temperature recorded during low flow was 14 C. Instream cover for juvenile rainbow-steelhead was 68% of the available area. No eroding stream banks were identified at this location. Mean water velocity was 83 cm/sec, well above the optimum values identified by Bovee (1978). The average stream width during low flow was 8.8 m. Mean water depth was 36 cm, an optimum depth for rainbow-steelhead juveniles (Bovee 1978). Cobble embeddedness was 25%, a value near the point which Bjornn et al (1977) found could limit salmonid production. The major substrate was small boulders, an optimum size for juvenile rainbow-steelhead (Bovee 1978). Periphyton coverage was 100%, indicating excellent production. The estimated pool riffle ratio was 10:90, indicating a severe lack of pool habitat. The general stream channel stability was excellent due to large substrate embedded in stream banks, well established woody overstory, and the presence of woody debris (Table 29b).

Table 27a. Water sample analysis from seven stations on Lol Creek, tributary of lower Clearwater River Basin, Idaho, 1983.

Constituent	Station 1 Value	Station 2 Value	Station 3 Value	Station 4 Value
Calcium, Ca, mg/1	3.93	3.37	3.70	2.06
Magnesium, Mg, mg/1	1.08	0.90	0.70	0.28
Sodium, Na, mg/1	3.26	2.53	3.19	2.51
Potassium, K, mg/1	0.94	0.53	0.63	<0.50
Chloride, Cl, mg/1	0.02	0.07	0.07	0.18
Carbonate, CO3, mg/1	<0.22	0	0	0
Bicarbonate, HCO3, mg/1	0.44	0.36	0.49	0.33
Sulfate, SO4, mg/1	1	1	<1	1
Nitrate, NO3, mg/1	<0.01	0.01	<0.01	<0.01
Orthophosphate, PO4, mg/1	<0.01	<0.01	0.01	0.01
Total Residue, mg/1	65	72	54	6
Non-Filtered Residue,mg/1	<1	<1	2	1
pH	7.3	7.8	8.1	7.4

Table 27b. Water sample analysis from seven stations on Lolo Creek, tributary of lower Clearwater River Basin, Idaho, 1983.

Constituent	Station 5 Value	Station 6 Value	Station 7 Value
Calcium, Ca, mg/1	2.29	2.29	1.76
Magnesium, Mg, mg/1	0.34	0.34	0.29
Sodium, Na, mg/1	2.63	2.63	1.94
Potassium, K, mg/1	<0.50	0.50	<0.50
Chloride, Cl, mg/1	0.11	0.11	0.18
Carbonate, CO3, mg/1	0	0	0
Bicarbonate, HCO3, mg/1	0.33	0.33	0.24
Sulfate, SO4, mg/1	1	1	1
Nitrate, NO3, mg/1	0.02	0.02	0.03
Orthophosphate, PO4, mg/1	0.01	0.01	0.01
Total Residue, mg/1	4	4	4
Non-Filtered Residue,mg/1	1	1	<1
pH	7.4	7.4	7.5

Table 28a. Fish population statistics for rainbow-steelhead trout on Lolo Creek, tributary of lower Clearwater River Basin, Idaho, 1982, 1983.

Biological Parameter	Units	Station 1[1] Value	Station 2 Value	Station 3 Value
Age 0+ Rainbow-Steelhead				
Density	$fish/m^2$		0	0
Standing Crop	kg/ha		0	0
Mean Weight	gm		0	0
Mean Length (TL-FL)	mm		0	0
Age 1+ Rainbow-Steelhead				
Density	$fish/m^2$		0.2	.004
Standing Crop	kg/ha		3.20	.62
Mean Weight	gm		17.2	17.2
Mean Length (TL-FL)	mm			

[1] Insufficient number of rainbow trout were collected to generate population estimates.

Table 28b. Fish population statistics for rainbow-steelhead trout on Lolo Creek, tributary of lower Clearwater River Basin, Idaho, 1982, 1983.

Biological Parameter	Units	Station 4 Value	Station 5 Value	Station 6 Value	Station 7 Value
Age 0+ Rainbow-Steelhead					
Density	fish/m^2	0.03	0.27	RB Present	RB Present
Standing Crop	kg/ha	0.9	3.0		
Mean Weight	gm	3.0	1.1		
Mean Length (TL-FL)	mm				
Age 1+ Rainbow-Steelhead					
Density	fish/m^2	0.2	0.13	RB Present	RB Present
Standing Crop	kg/ha	2.9	22.2		
Mean Weight	gm	17.2	17.2		
Mean Length (TL-FL)	mm				

Table 29a. Measured physical parameters from seven stations on Lolo Creek, tributary of lower Clearwater River Basin, Idaho, 1982, 1983.

Physical Parameter	Station 1 Value	Station 2 Value	Station 3 Value
Late Summer Stream Flow (m^3/sec)	4.4	4.1	4.3
Annual Stream Flow Variation	Moderate	Moderate	Moderate
Maximum Summer Temp. (C)	21.7	16	21
Instream Cover (%)	28	26	8
Eroding Banks (% of banks)	11.1	0	0
Water Velocity (cm/sec)	65	65	58
Stream Width (m)	11.2	11.8	18.7
Stream Depth (cm)	60	53	49
Cobble Embeddedness (%)	60	25	75
Major Substrate Type	Large Rubble	Large Rubble	Sand
Periphyton Coverage	50%	40%	100%
Pool Riffle Ratio	35:65	30:70	30:70

Table 29b. Measured Physical Parameters from seven stations on Lolo Creek, tributary of lower Clearwater River Basin, Idaho, 1982, 1983.

Physical Parameter	Station 4 Value	Station 5 Value	Station 6 Value	Station 7 Value
Late Summer Stream Flow (m^3/sec)	1.3	1.3	1.3	1.6
Annual Stream Flow Variation	Moderate	Moderate	Moderate	Small
Maximum Summer Temp. (C)	18	14	14	14
Instream Cover (%)	21	23	7	68
Eroding Banks (% of banks)	23	6	0	0
Water Velocity (cm/sec)	85	46	43	83
Stream Width (m)	6.9	9.5	12.7	8.8
Stream Depth (cm)	22	30	34	36
Cobble Embeddedness (%)	20	15	25	25
Major Substrate Type	Small Rubble	Large Rubble	Small Rubble	Small Boulder
Periphyton Coverage (%)	100	100	100	100
Pool Riffle Ratio	40:60	50:50	10:90	10:90

Yakus Creek

Yakus Creek originates in the Clearwater National Forest just east of the western forest boundary. The stream flows north for 8.9 kilometers before entering Lolo Creek. This stream has a relatively steep gradient except for the lower 3.2 kilometers. A well maintained road parallels the stream at stream level and riparian buffer zones are relatively intact. Impact to the stream has been kept to a minimum. Water quality analysis did not identify any limiting factors to salmonid production (Table 30).

Two stations were selected on Yakus Creek: station #l, located 2.4 kilometers from the mouth, and station #2, established below the confluence of the two major tributaries at SK 4.9.

Station #l

Rainbow trout and sculpins were collected at this lower station. The standing crop of subyearling rainbow-steelhead trout was 6.7 kg/ha, with a density of 0.6 fish/m2. Overyearling estimates were 31.6 kg/ha, with a density of 0.2 fish/m2 (Table 31).

Late summer stream flow was 0.33 m3/sec, with moderate annual stream flow variation. The maximum water temperature was 14 c, well below the lethal limits for salmonids. Instream cover for juvenile rainbow-steelhead was 12% of available area. Erosion of stream banks was 86%. Mean water velocity was 53 cm/sec, slightly above optimum for juvenile rainbow-steelhead (Bovee

1978). The average width during low flow was 5.97 m. Mean water depth was 11 cm, below the optimum values for juvenile rainbow-steelhead {Bovee 1978). Cobble embeddedness was 0. The major substrate type was small rubble, an optimum size for juverile rainbow-steelhead (Bovee 1978). Coverage of the substrate by periphyton was 60%, indicating moderate productivity. The pool riffle ratio of 10:90 indicated a severe lack of pool habitat. The general channel stability was fair due to bank erosion and lack of large substrate (Table 31).

Station #2

Rainbow and cutthroat trout were collected at this station. In addition, sculpins were found in moderate numbers. No subyearling rainbow-steelhead trout were collected. Standing crop of overyearllng rainbow steelhead trout was 12.0 kg/ha, with a density of 0.7 fish/m2 (Table 31).

Late summer stream flow was 0.24 m3/sec, with moderate annual stream flow variation. The maximum water temperature during low flow was 11 c, well below the lethal limits for salmonids. Instream cover was 27% of available area. No bank erosion was identified. Mean water velocity was 41 cm/sec, an optimum value for juvenile rainbow-steelhead (Bovee 1978). The average stream width at low flow was 3.93 m. Mean water depth was 15 cm, shallower than optimal for juvenile rainbow-steelhead (Bovee 1978). Cobble embeddedness was 40%, a value which could limit salmonid production (Bjornn et al 1977). The major substrate was small rubble, an optimal substrate size for steelhead juveniles

(Bovee 1978). Periphyton coverage of the substrate was 25%, indicating moderate productivity. The estimated pool riffle ratio of 20:80 indicated a lack of pool habitat for overyearling fish. The channel integrity in this reach was excellent due to well developed riparian vegetation and large substrate in the bank structure (Table 32).

Table 30. Water sample analysis from one station on Yakus Creek, tributary of Lolo Creek, Idaho, 1983.

Constituent	Station 1 Value
Calcium, Ca, mg/1	5.70
Magnesium, Mg, mg/1	1.49
Sodium, Na, mg/1	3.46
Potassium, K, mg/1	0.88
Chloride, Cl, mg/1	0.15
Carbonate, CO3, mg/1	0
Bicarbonate, HCO3, mg/1	0.53
Sulfate, SO4, mg/1	1
Nitrate, NO3, mg/1	0.01
Orthophosphate, PO4, mg/1	0.03
Total Residue, mg/1	20
Non-Filtered Residue, mg/1	1
pH	7.60

Table 31. Fish population statistics for rainbow-steelhead trout on Yakus Creek, tributary of Lolo Creek, Idaho, 1982, 1983.

Biological Parameter	Units	Station 1 Value	Station 2 Value
Age 0+ Rainbow-Steelhead			
Density	fish/m^2	0.6	0
Standing Crop	kg/ha	6.7	0
Mean Weight	gm	1.1	0
Mean Length (TL-FL)	mm	53-51	0
Age 1+ Rainbow-Steelhead			
Density	fish/m^2	0.2	0.7
Standing Crop	kg/ha	31.6	12.0
Mean Weight	gm	17.2	17.2
Mean Length (TL-FL)	mm	118-111	135-128

Table 32. Measured physical parameters from two stations on Yakus Creek, tributary of Lolo Creek, Idaho, 1983.

Physical Parameter	Station 1 Value	Station 2 Value
Late Summer Stream Flow (m3/sec)	0.33	0.24
Annual Stream Flow Variation	Moderate	Moderate
Maximum Summer Temp. (C)	14	11
Instream Cover (%)	12	27
Eroding Banks (% of banks)	86	0
Water Velocity (cm/sec)	53	41
Stream Width (m)	5.97	3.93
Stream Depth (cm)	11	15
Cobble Embeddedness (%)	0	40
Major Substrate Type	Small Rubble	Small Rubble
Periphyton Coverage (%)	60%	25%
Pool Riffle Ratio	10:90	20:80

Musselshell Creek

Musselshell Creek is approximately 23.5 kilometers long. The stream flows in the southwesterly direction to its confluence with Lolo Creek at SK 42.6. The major tributary to lower Musselshell Creek is Browns Creek. The stream originates in the Clearwater National Forest east of Weippe, Idaho. Logging activity, past and present, is found throughout the upper tributary system. The stream flows through Musselshell Meadows, adjacent to a USFS work camp. At this point a large pond and spawning channel are present but in degraded condition. From' this point downstream to the confluence of Browns Creek, the riparian habitat has been degraded by grazing activities. From the confluence of Browns Creek to Lolo Creek the stream flows through a canyon environment with very little access. The Musselshell drainage is subject to intensive sedimentation and has deposits of large sand the entire length of the stream. Water quality analysis did not identify any limiting factors to salmonid production (Table 33).

One station was located adjacent to the Musselshell work station, representing the majority of the lower system at SK 9.7.

Station #1

Several brook trout and dace were captured at this station and no rainbow-steelhead trout were seen (Table 34).

Late summer stream flow was 0.22 m3/sec, with moderate annual stream flow variation. The maximum water temperature was 19.4 C, approaching the lethal limits for salmonid production. Instream cover for juvenile rainbow-steelhead was 10% of the available area. Bank erosion was 55% of the banks surveyed. Mean water velocity was 8.5 cm/sec slightly below optimum values for juvenile rainbow-steelhead trout (Bovee 1978). The average stream width was 5.58 m. Mean water depth was 47 cm, an optimum depth for juvenile rainbow-steelhead trout (Bovee 1978). Cobble embeddedness was 40%, which can limit salmonid production (Bjornn et al 1977). The major substrate was deep sand, which is a sub-optimum substrate size for these fish (Bovee 1978). Coverage of the substrate by periphyton was 60%, indicating good productivity. A pool riffle ratio of 80:20 indicated plentiful pool habitat (Table 35).

Table 33. Water sample analysis from one station on Musselshell Creek, tributary of Lolo Creek, Idaho, 1983.

Constituent	Station 1 Value
Calcium, Ca, mg/l	7.48
Magnesium, Mg, mg/l	1.93
Sodium, Na, mg/l	3.36
Potassium, K, mg/l	0.78
Chloride, Cl, mg/l	0.20
Carbonate, CO3, mg/l	0
Bicarbonate, HCO3, mg/l	0.65
Sulfate, SO4, mg/l	2
Nitrate, NO3, mg/l	<0.01
Orthophosphate, PO4, mg/l	0.02
Total Residue, mg/l	38
Non-Filtered Residue, mg/l	1
pH	7.65

Table 34. Fish population statistics for rainbow-steelhead trout on Musselshell Creek, tributary of Lolo Creek, Idaho, 1982, 1983.

Biological Parameter	Units	Station 1 Value
Age 0+ Rainbow-Steelhead		
Density	fish/m^2	0
Standing Crop	kg/ha	0
Mean Weight	gm	0
Mean Length (TI-FL)	mm	0
Age 1+ Rainbow-Steelhead		Brook Trout
Density	fish/m^2	
Standing Crop	kg/ha	
Mean Weight	gm	
Mean Length (TL-FL)	mm	

Table 35. Measured Physical Parameters from one station on Musselshell Creek, tributary of Lolo Creek, Idaho, 1983,

Physical Parameter	Station 1 Value
Late Summer Stream Flow (m^3/sec)	0.22
Annual Stream Flow Variation	Moderate
Maximum Summer Temp. (C)	19.4
Instream Cover (%)	10
Eroding Banks (% of banks)	55
Water Velocity (cm/sec)	8.5
Stream Width (m)	5.58
Stream Depth (cm)	47
Cobble Embeddedness (%)	40
Major Substrate Type	Sand
Periphyton Coverage (%)	60
Pool Riffle Ratio	80:20

Browns Creek

Browns Creek originates east of Weippe, Idaho and flows 13.8 kilometers in a southerly direction and enters Musselshell Creek at SK 4.8. This drainage has been extensively and intensively logged and roaded (Espinosa 1975). Road construction and skid trail operation in intermittent stream channels and little or no buffer strips along streams have also been observed (Espinosa 1975). In addition, range and farming practices on the eastern portion of the Weippe prairie, including' riparian zone destruction and overstory cutting, have contributed to the sediment load into this creek. The entire mainstem creek, to its confluence with Musselshell Creek, has a degraded riparian zone. "The Browns Creek watershed appears to be the most significant, chronic source of sediment that impacts **lower** Lo10 below the Musselshell confluence" (Espinosa 1975). Water quality analysis did not identify any limiting factors to salmonid production (Table 36).

Due to the intermittent nature of the tributaries and general condition of this stream only one station was established, approximately 1.9 kilometers above the confluence with Musselshell Creek. Redside shiners were the most abundant species captured.

Station #1

Sculpins and speckled dace, brook trout and 2 subyearling rainbow cutthroat hybrids were present. The field size of the generator and the lack of visibility for snorkling precluded a quantitative evaluation of fish populations (Table 37).

Low summer stream flow was 0.33 m3/sec, with moderate variation in annual stream flow. The maximum water temperature during low flow was 16 C, which is below the lethal limits for salmonid production. Instream cover for salmonids was 7% of the total area available. Stream bank erosion was 53%. Mean water velocity was 21 cm/sec, an optimum value for juvenile rainbow-steelhead (Bovee 1978).The average width of Browns Creek during low flow was 5.2 m. The mean water depth was 28 cm,slightly below optimum for juvenile rainbow-steelhead (Bovee 1978). Cobble embeddedness was lOO%, which can limit salmonid production (Bjornn et al 1977). The major substrate type was sand, silt and clay. The coverage of the substrate by periphyton was 20% indicating poor productivity due to constant silt deposition. The pool riffle ratio was 80:20, indicating plentiful pool habitat. The channel integrity was poor due to excessive bank erosion and lack of bank structure (Table 38).

Table 36. Water sample analysis from one station on Browns Creek, tributary of Lolo Creek, Idaho, 1983.

Constituent	Station 1 Value
Calcium, Ca, mg/1	6.54
Magnesium, Mg, mg/l	1.69
Sodium, Na, mg/l	3.30
Potassium, K. mg/l	0.89
Chloride, Cl, mg/l	0.20
Carbonate, C03, mg/l	0
Bicarbonate, HC03, mg/l	0.65
Sulfate, S04, mg/l	2
Nitrate, N03, mg/l	<0.0l
Orthophosphate, P04, mg/l	0.02
Total Residue, mg/l	38
Non-Filtered Residue, mg/l	1
PH	7.65

Table 37, Fish population statistics for rainbow-steelhead trout on Brown's Creek, tributary to Lolo Creek, Idaho, 1983.

Biological Parameter	Units	Station 1 Value
Age 0+ Rainbow-Steelhead		
Density	fish/m^2	0
Standing Crop	kg/ha	0
Mean Weight	gm	0
Mean Length (TL-FL)	mm	0
Age 1+ Rainbow-Steelhead		B
Density	fish/m^2	r o
Standing Crop	kg/ha	o k
Mean Weight	gm	T r
Mean Length (TL-FL)	mm	o
Condition Factor (XK)		u t

Table 38. Measured physical parameters from one station on Browns Creek, tributary of Lolo Creek, Idaho, 1983.

Physical Parameter	Station 1 Value
Late Summer Stream Flow (m^3/sec)	0.33
Annual Stream Flow Variation	Moderate
Maximum Summer Temp. (C)	16
Instream Cover (5)	7
Eroding Banks (% of banks)	53
Water Velocity (cm/sec)	21
Stream Width (m)	5.2
Stream Depth (cm)	28
Cobble Embeddedness (%)	100
Major Substrate Type	
Periphyton Coverage (%)	20
Pool Riffle Ratio	80:20

Eldorado Creek

Eldorado Creek is approximately 26.5 kilometers in length. The stream flows in a northwesterly direction and enters Lolo Creek at SK 41.8. Several major barriers to upstream movement were identified in the lower 3.2 kilometers of stream. These included a series of cascades with bedrock substrate, a sheer falls of approximately 3.7 meters, and a jumble of large boulders above the falls of natural origin with the addition of some large boulders from adjacent road construction. The middle reach of Eldorado Creek has moderately steep gradient characterized by good riparian habitat and tall overstory. The upper reaches of the stream have less gradient and less velocity. Meadowland with abundant top soil is common in this area. The stream has abundant pool habitat and plentiful woody debris, although the riparian habitat is not always present. Water quality analysis did not identify any chemical limitations to salmonid production (Table 39).

Three stations were established on Eldorado Creek: station #l, located at SK 3.7; station #2, located at SK 7.6; and station #3, located at SK 11.3, adjacent to Salmon Trout Camp.

Station #l

Cutthroat trout was the only species of fish found at this location (Table 40). Few individuals were seen at this location and visibility precluded an accurate population estimate.

Late summer stream flow was 0.93 m3/sec, with moderate annual stream flow variation. The maximum summer water temperature was 16 C, well below the lethal limits for salmonids. Instream cover was 6% of the total area available and no bank erosion was observed. Mean water velocity was 34 cm/sec, which is optimum for juvenile rainbow-steelhead (Bovee 1978). The average stream width during low flow was 11.84 m. The water depth was 23 cm, below that identified as optimum for juvenile rainbow-steelhead (Bovee 1978). Cobble embeddedness was 0. The major substrate was small rubble, an optimum size for juvenile steelhead (Bovee 1978). Periphyton coverage was l00%, indicating good productivity. The pool riffle ratio was 80:20, indicating an abundance of pool habitat (Table 41).

Station #2

Cutthroat trout was the only species of fish found at this location but population estimates were not made (Table 40).

Late summer stream flow was 0.93 m3/sec, with moderate annua 1 stream flow variation. The maximum summer water temperature was 15 c, well below the lethal limits for salmonid production. Instream cover for juvenile rainbow-steelhead was 12% of the available area and no bank erosion was identified. Mean water velocity was 30 cm/sec, an optimum value for juvenile rainbow-steelhead (3ovee 1978). The average stream width during low flow was 8.02 m. Mean water depth was 40 cm, an optimum value for juvenile rainbow-steelhead trout (Bovee 1978). Cobble embeddedness was 50%, which could possibly limit salmonid production at this location. The major substrate was large rubble, an optimum size for these fish (Bovee 1978). Periphyton coverage of the substrate was 70% indicating good productivity. The pool riffle ratio was 60:40, an optimal ratio for salmonid streams (Table 41).

Station #3

Cutthroat trout was the only species of fish found at this location. Densities of subyearling and overyearling cutthroat trout were 0.23/m2 and 0.30/m2, respectively (Table 40).

Late summer stream flow was 0.41 m3/sec, with practically no annual stream flow variation. The maximum water temperature was 16 C, well below the lethal limits for salmonid production. Instream cover for juvenile rainbow-steelhead was 31% of the available area and all banks showed signs of erosion. Mean water velocity was 10 cm/sec, slightly below the optimum value for juvenile rainbow-steelhead (Bovee 1978). The average stream width during low flow was 10.02 m. Mean water depth was 43 cm, an optimum value for juvenile rainbow-steelhead (Bovee 1978). Cobble embeddedness was l00% which can limit salmonid production (Bjornn et al 1977). The major substrate was sand, a sub-optimum substrate size for these fish (Bovee 1978). Periphyton coverage was 0% and the pool riffle ratio was 100:0, indicating plentiful pool habitat but a lack of riffle area (Table 41).

Table 39. Water sample analysis from three stations on Eldorado Creek, tributary of Lolo Creek, Idaho, 1983.

Constituent	Station 1	Station 2	Station 3
	Value	Value	Value
Calcium, Ca, mg/1	3.11	2.75	2.10
Magnesium, Mg, mg/1	0.46	0.29	<0.25
Sodium, Na, mg/1	3.11	3.82	3.10
Potassium, K, mg/1	<0.5	0.52	0.50
Chloride, Cl, mg/1	0.16	0.18	0.14
Carbonate, CO3, mg/1	NIL	NIL	NIL
Bicarbonate, HCO3. mg/1	0.41	0.33	0.28
Sulfate, SO4, mg/1	1	1	1
Nitrate, NO3, mg/1	>0.01	>0.01	0.01
Orthophosphate, PO4, mg/1	0.01	0.01	0.01
Total Residue, mg/1	20	16	6
Non-Filtered Residue, mg/1	1	2	>1
pH	7.54	7.45	7.28

Table 40. Fish population statistics for cutthroat trout on Eldorado Creek, tributary of Lolo Creek, Idaho, 1982, 1983.

Biological Parameter	Units	Station 1 Value	Station 2 Value	Station 3 Value
Age 0+ Rainbow-Steelhead				
Density	fish/m^2	*		0.23
Standing Crop	kg/ha			
Mean Weight	gm			
Mean Length (TL-FL)	mm			
Age 1+ Rainbow-Steelhead				
Density	fish/m^2			0.30
Standing Crop	kg/ha			
Mean Weight	gm			
Mean Length (TL-FL)	mm			

* Information not collected by visual observation techniques.

Table 41. Measured physical parameters from three stations on Eldorado Creek, tributary of Lolo Creek, Idaho, 1983.

Physical Parameter	Station 1 Value	Station 2 Value	Station 3 Value
Late Summer Stream Flow (m3/sec)	0.93	0.93	0.41
Annual Stream Flow Variation	Moderate	Moderate	Slight
Maximum Summer Temp. (C)	16	15	16
Instream Cover (%)	6	12	31
Eroding Banks (% of banks)	0	0	100
Water Velocity (cm/sec)	34	30	10
Stream Width (m)	11.84	8.02	10.02
Stream Depth (cm)	23	40	43
Cobble Embeddedness (%)	0	50	100
Major Substrate Type	Small Rubble	Large Rubble	Sand
Periphyton Coverage (%)	100	70	0
Pool Riffle Ratio	80:20	60:40	100:0

Yoosa Creek

Yoosa Creek is approximately 10.6 kilometers in length. The stream flows in a northwesterly direction and enters Lolo Creek at SK 56.6. Degredation within this watershed is less than other Lolo Creek subdrainages surveyed. Yoosa Creek flows for most of its length through forested terrain. The overall gradient of the stream is moderate 3.6% (Espinosa 1975). Generally the stream has good habitat for salmonid rearing with abundant pool habitat and good riparian cover.The primary concern would be forest road (103) which parallels the stream and could potentially provide a source of erosion and sediment input into the stream. Water quality analysis did not identify any chemical limitations to salmonid production (Table 42).

One station was located on Yoosa Creek at SK 3.3 to represent the lower reaches. The densities of subyearling and overyearling rainbow-steelhead were 0.03 fish/m2 (Table 43). Standing crop estimates were not calculated since weights were not recorded. One cutthroat trout overyearling was observed.

Late summer stream flow was 0.7 m3/sec, with moderate annual stream flow variation. The maximum water temperature was 8.9 C, well below the lethal limits to salmonid production. Cover for rainbow-steelhead juveniles was 53% of the total area surveyed. NO eroding banks were observed. Mean water velocity was 32 cm/sec, an optimum value for rainbow-steelhead juveniles (Bovee

1978). Average stream width during low flow was 7.6 m. Mean water depth was 28 cm, slightly below optimum values for rainbow-steelhead juveniles (Bovee 1978). Cobble embeddedness was 608, which can limit salmonid production (Bjornn et al 1977). The major substrate type was small boulder, an optimum size for rainbow-steelhead juveniles (Bovee 1978). Periphyton coverage was 808, indicating good productivity. The pool riffle ratio was 50:50, indicating a good balance of pool and riffle habitat (Table 44).

Table 42. Water sample analysis from one station on Yoosa Creek, tributary of Lolo Creek, Idaho, 1983.

Constituent	Station 1 Value
Calcium, Ca, mg/l	2.49
Magnesium, Mg, mg/l	0.45
Sodium, Na, mg/l	2.69
Potassium, K, mg/l	<0.50
Chloride, Cl, mg/l	0.16
Carbonate, C03, mg/l	0
Bicarbonate, HC03, mg/l	0.20
Sulfate, S04, mg/l	1
Nitrate, N03, mg/l	0.08
Orthophosphate, P04, mg/l	0.01
Total Residue, mg/l	6
Non-Filtered Residue, mg/l	<l
PH	7.42

Table 43. Fish population statistics for rainbow-steelhead trout on Yoosa Creek, tributary of Lo10 Creek, Idaho, 1982, 1983.

Biological Parameter	Units	Station 1 Value
Age 0+ Rainbow-Steelhead		
Density	fish/m^2	0.03
Standing Crop	kg/ha	
Mean Weight	gm	
Mean Length (TL-FL)	mm	
Age 1+ Rainbow-Steelhead		
Density	fish/m^2	0.03
Standing Crop	kg/ha	
Mean Weight	gm	
Mean Length (TL-FL)	mm	

Table 44. Measured physical parameters from one station on Yoosa Creek, tributary of Lolo Creek, Idaho, 1983.

Physical Parameter	Station 1 Value
Late Summer Stream Flow (m3/sec)	0.7
Annual Stream Flow Variation	Moderate
Maximum Summer Temp. (C)	8.9
Instream Cover (%)	53
Eroding Banks (% of banks)	0
Water Velocity (cm/sec)	32
Stream Width (m)	7.6
Stream Depth (cm)	28
Cobble Embeddedness (%)	60
Major Substrate Type	Small Boulder
Periphyton Coverage (%)	80%
Pool Riffle Ratio	50:50

Maggie Creek

Maggie Creek flows for approximately 23.5 kilometers, of which 5.5 kilometers flow through the Nez Perce Reservation, and flows southwesterly to its, confluence with the Middle Fork Clearwater River. Maggie Creek originates in Idaho State forest land and flows for its entire length through steep canyon terrain. The riparian zone is good throughout the system with the exception of the lowest 3.2 kilometers. Water quality analysis indicates no limitation to salmonid production (Table 45).

Two stations were established on this stream: station #l, located at SK 1.3 during 1982 to represent the lower reaches, and station #2 located at SK 1.63 during the summer 1983 to represent the upper reaches.

Station #1

Rainbow-steelhead trout, northern squawfish, bridgelip sucker, redside shiner, dace, and sculpin were collected. Estimated standing crop for overyearling rainbow-steelhead was 15.9 kg/ha, with a density of 0.07 fish/m2. Subyearling steelhead were not captured in sufficient numbers to calculate estimates of abundance (Table 46).

Late summer flow was 0.05 m3/sec, with an extreme variation in annual stream flow. The maximum water temperature recorded was 24.4 C, which can limit the production of juvenile salmonids. Instream cover was 3% of the total area surveyed. Twelve percent of the stream banks showed signs of erosion. Mean water velocity was 13 cm/set, which is at the lower range of water velocities most preferred by juvenile rainbow-steelhead(Bovee 1978). The stream width averaged 3.25 m at low flow. Mean water depth was 10 cm, which is below the preferred depth of juvenile rainbow-steelhead (Bovee 1978). Cobble embeddedness was 408, which may reduce salmonid production (Bjornn et al 1977). The major substrate was small rubble, which is near optimum size for juvenile rainbow-steelhead (Bovee 1978). Periphyton covered 70% of the substrate, indicating good productivity. A pool riffle ratio of l0:90 indicated a lack of holding area for juvenile rainbow-steelhead. The general stability of the stream banks was moderate (Table 47).

Station #2

Rainbow-steelhead and dace were the only species captured. Estimated overyearling rainbow-steelhead standing crop was 17.1 kg/ha, with a density of 0.09 fish/m2. The subyearling rainbow-steelhead standing crop estimate was 3.3 kg/ha, with a density of 0.25 fish/m2 (Table 46).

Low summer flow was 0.11 m3/sec, with moderate variation in annual stream flow. The maximum water temperature recorded was 16.7 C, within the tolerance of salmonids. Thirteen percent of the area surveyed provided cover for juvenile rainbow-steelhead. Forty nine percent of stream banks surveyed showed signs of erosion. Mean water velocity was 25 cm/sec, which is within the optimum range preferred by juvenile rainbow-steelhead (Bovee 1978). The stream width averaged 4.28 m at low flow. Mean water depth was 10 cm, which is less than the preferred depth of juvenile steelhead (Bovee 1978). Cobble embeddedness was 25%, which should not limit salmonid production (Bjornn et al 1978).The major substrate was small rubble, near optimum size for juvenile steelhead (Bovee 1978), Periphyton coverge of the substrate was 100%, indicating good primary productivity. The pool riffle ratio of 20:80 identified a lack of holding area for overyearling salmonids. In general, the stability of this stream was good except that the riparian zone has no influence on the channel at low flow (Table 47).

Table 45. Water sample analysis from two stations on Maggie Creek, tributary of M.F. Clearwater River Basin, Idaho, 1982, 1983.

Constituent	Station 1 Value	Station 2 Value
Calcium, Ca, mg/1	7.5	7.9
Magnesium, Mg, mg/1	3.0	2.6
Sodium, Na, mg/1	4.9	4.1
Potassium, K, mg/1	2.8	2.3
Chloride, Cl, mg/1	<0.01	0.07
Carbonate, CO3, mg/1	<0.22	0.24
Bicarbonate, HCO3, mg/1	0.88	2.65
Sulfate, SO4, mg/1	1.0	1.0
Nitrate, NO3, mg/1	<0.01	0.01
Orthophosphate, PO4, mg/1	0.02	0.03
Total Residue, mg/1	95	114
Non-Filtered Residue, mg/1	<1	7
pH	7.6	7.6

Table 46. Fish population statistics for rainbow-steelhead trout on Maggie Creek, tributary of M.F. Clearwater River Basin, Idaho, 1982, 1983.

Biological Parameter	Units	Station 1 Value	Station 2 Value
Age 0+ Rainbow-Steelhead			
Density	Fish/m2		0.25
Standing Crop	kg/ha		3.3
Mean Weight	gm		1.3
Mean Length (TL-FL)	mm		55-43
Age 1+ Rainbow-Steelhead			
Density	Fish/m2	0.07	0.09
Standing Crop	kg/ha	15.9	17.1
Mean Weight	gm	22.0	18.9

Table 47. Measured physical parameters from two stations on Maggie Creek, tributary of M.F Clearwater River Basin, Idaho, 1982, 1983.

Physical Parameter	Station 1 Value	Station 2 Value
Late Summer Stream Flow (m3/sec)	0.05	0.11
Annual Stream Flow Variation	Extreme	Moderate
Maximum Summer Temp. (C)	24.4	16.7
Instream Cover (%)	3	13
Eroding Banks (% of banks)	12	49
Water Velocity (cm/sec)	13	25
Stream Width (m)	3.25	4.28
Stream Depth (cm)	10	10
Cobble Embeddedness (%)	40	25
Major Substrate Type	Small Rubble	Small Rubble
Periphyton Coverage	70%	100%
Pool Riffle Ratio	10:90	20:80

Mission Creek

Although the vast majority of Mission Creek was surveyed in 1982 (Kucera et al 1983), the uppermost reach of this stream was surveyed during the summer of 1983. The upper reaches are heavily grazed by cattle and subject to degradation by road construction and heavy equipment use. The stream flows through intermittent forest and meadow habitats. The sampling station was located 3.2 km north of Forest, Idaho at SK 31.9. The following survey results are an appendum to the 1983 report. Water analysis did not indicate any limitations to salmonid production (Table 48).

Headwaters Station (#5)

Rainbow-steelhead trout and speckled dace were captured during the summer of 1983. Estimated standing crop of overyearling rainbow-steelhead was 15.53 kg/ha, with a density of 0.03 fish/m2. No subyearling salmonids were captured (Table 49).

Late summer stream flow was 0.03 m3/sec, with moderate annual variation in flow. The maximum water temperature recorded was 21.1 c, which is close to the upper lethal limit for salmonids. Two percent of the area surveyed provided cover for overyearling rainbow-steelhead and 41% and of the stream banks showed signs of erosion. Mean water velocity was 17 cm/sec, which is near optimum for this species (Bovee 1978). The average stream width was 1.5 m during low flow. Mean stream water depth was 12 cm, below the optimum value described by Bovee (1978).

Cobble embeddedness was 25%, which should not impair salmonid production (Bjornn et al 1977). The major substrate was small rubble near the optimum size for juvenile rainbow-steelhead (Bovee 1978). Periphyton coverage was 80%, indicating good productivity. The pool riffle ratio was 20:80, indicating a lack of pool or holding area for overyearling rainbow-steelhead. Bank and stream stability was poor due to the lack of riparian vegetation and surrounding soil substrate (Table 50).

Table 48. Water sample analysis from one station on Mission Creek, Tributary of Lapwai Creek, Idaho, 1983.

Constituent	Station 5 Value
Calcium, Ca, mg/1	7.27
Magnesium, Mg, mg/1	2.44
Sodium, Na, mg/1	3.87
Potassium, K, mg/1	2.26
Chloride, Cl, mg/1	0.05
Carbonate, CO_3, mg/1	0.08
Bicarbonate, HCO_3, mg/1	0.53
Sulfate, SO_4, mg/1	3
Nitrate, NO_3, mg/1	0.01
Orthophosphate, PO_4, mg/1	0.02
Total Residue, mg/1	192
Non-Filtered Residue, mg/1	1
pH	8.07

Table 49. Fish population statistics for rainbow-steelhead trout on Mission Creek, Tributary of Lapwai Creek, Idaho, 1983.

Biological Parameter	Units	Station 5 Value
Age 0+ Rainbow-Steelhead		
Density	fish/m^2	0
Standing Crop	kg/ha	0
Mean Weight	gm	0
Mean Length (TL-FL)	mm	0
Age 1+ Rainbow-Steelhead		
Density	fish/m^2	0.03
Standing Crop	kg/ha	15.53
Mean Weight	gm	15.25
Mean Length (TL-FL)	mm	176-168

Table 50. Measured physical parameters from one station on Mission Creek, tributary of Lapwai Creek, Idaho, 1983.

HQI Attribute	Station 5 Value
Late Summer Stream Flow (%) (m3/sec)	0.03
Annual Stream Flow Variation	Moderate
Maximum Summer Temp. (C)	21.1
Cover (% area)	2
Eroding Banks (% of banks)	41
Water Velocity (cm/sec)	17
Stream Width (m)	1.5
Stream Depth (cm)	12
Cobble Embeddedness (%)	25
Major Substrate Type	Small Rubble
Periphyton Coverage	80
Pool Riffle Ratio	20:80

Pine Creek

Pine Creek flows for approximately 22.5 kilometers of which 4.0 kilometers flow within the Nez Perce Reservation boundary. At low summer flow the stream is reduced to about 11.3 kilometers in length. The stream arises in farmland adjacent to Leland, Idaho, flows intermittently for about 6.4 kilometers, and then drops into a moderately steep sided canyon, meeting the mainstem Clearwater River at RK 28.8. The lower two miles of this canyon provide grazing and agricultural activities. The riparian vegetation appears to be in good shape, with the exception of the upper agricultural reaches and near the mouth. Water quality analysis showed no indication of factors limiting salmonid production (Table 51).

Two stations were established on Pine Creek to represent the two main habitats present: station #1, located at SK 1.6;and station #2, located at SK 6.4. Beyond this point upstream movement of adult fish would be impaired by channel size and a series of small falls.

Station #1

Speckled dace and rainbow-steelhead trout were the only species captured. Estimated standing crop for overyearling rainbow-steelhead was 17.3 kg/ha, with a density of 0.10 fish/m2. The estimated standing crop of subyearling steelhead was 0.9kg/ha, with a density of 0.03 fish/m2 (Table 52).

Late summer stream flow was 0.05 m3/sec, with moderate annual stream flow variation. The maximum water temperature recorded during low flow was 16 C, which is within the tolerance of of rainbow-steelhead trout. Nine percent of the area surveyed provided cover for overyearling rainbow-steelhead and 94% of the stream banks showed erosion problems. The mean water velocity was 11 cm/sec, lower than that most preferred velocities by rainbow-steelhead (Bovee 1978). The mean stream width was 3.34 m during low flow. The average stream depth was 13 cm, less than that most preferred depth of juvenile rainbow trout (Bovee 1978). Cobble embeddedness was 25%, which is probably not limiting to salmonid production (Bjornn et al 1977). The major substrate identified was large rubble, the most preferred by juvenile rainbow trout (Bovee 1978). Periphyton coverage was 808, indicating good productivity. The pool riffle ratio of 20:80 indicated a lack of holding area for overyearling steelhead trout. The general stability of this section of stream was fair (Table 53).

Station #2

Speckled dace, sculpin, and rainbow-steelhead trout were the only species captured. The estimated standing crop of overyearling rainbow-steelhead was 37.8 kg/ha, with a density of 0.25 fish/m2. Standing crop of subyearling rainbow-steelhead was 18.4 kg/ha, with a density of 0.98 fish/m2 (Table 52).

Late summer stream flow was 0.04 m3/sec, with moderate annual variation in flow. The maximum water temperature recorded during low flow was 16 C, within the tolerances of rainbow-steelhead trout. Twenty two percent of the area surveyed provided cover for overyearling steelhead trout. Erosion was identified on 66% of the stream banks. Mean water velocity was 9 cm/ sec, below the optimum velocities identified by Bovee (1978) for this species. The mean stream width was 2.61 m at low flow. Mean stream depth was 16 cm, below the optimum for rainbow-steelhead juveniles (Bovee 1978). Cobble embeddedness was 50%, a point at which Bjornn et al (1977) indicated salmonid production could be inhibited. Major substrate identified was large rubble, which is optimum for juvenile rainbow-steelhead (Bovee 1978). Periphyton coverage was 80%, indicating good productivity. The pool riffle ratio was 50:50, providing both cover and food production for juvenile rainbow-steelhead. The stability of the banks and the general stability of the stream was good due to the large substrate (boulders, ect.) reinforcing the banks and stream channel (Table 53).

Table 51. Water sample analysis from two stations on Pine Creek, tributary to lower Clearwater River Basin, Idaho, 1983.

Constituent	Station 1 Value	Station 2 Value
Calcium, Ca, mg/1	28.59	32.64
Magnesium, Mg, mg/1	9.72	10.74
Sodium, Na, mg/1	11.80	12.57
Potassium, K, mg/1	5.05	4.09
Chloride, Cl, mg/1	0.08	0.06
Carbonate, CO3, mg/1	0.16	0.33
Bicarbonate, HCO3, mg/1	2.04	2.24
Sulfate, SO4, mg/1	1	1
Nitrate, NO3, mg/1	0.13	0.51
Orthophosphate, PO4, mg/1	0.17	0.18
Total Residue, mg/1	218	266
Non-Filtered Residue, mg/1	<1	<1
pH	7.93	8.27

Table 52. Fish population statistics for rainbow-steelhead trout on Pine Creek, tributary of lower Clearwater River Basin, Idaho, 1983.

Biological Parameter	Units	Station 1 Value	Station 2 Value
Age 0+ Rainbow-Steelhead			
Density	fish/m^2	0.03	0.98
Standing Crop	kg/ha	0.~~9~~ 73	18.4
Mean Weight	gm	~~1.0~~ 2.8	1.8
Mean Length (TL-FL)	mm	66-6~~1~~2	64-62
Age 1+ Rainbow-Steelhead			
Density	fish/m^2	0.10	0.25
Standing Crop	kg/ha	17.3	37.8
Mean Weight	gm	17.1	15.2
Mean Length (TL-FL)	mm	121-114	119-104

Table 53. Measured physical parameters from two stations on Pine Creek, tributary of lower Clearwater River Basin, Idaho, 1983.

Physical Parameter	Station 1	Station 2
	Value	Value
Late Summer Stream Flow (m3/sec.)	0.05	0.04
Annual Stream Flow Variation	Moderate	Moderate
Maximum Summer Temp. (C)	16	16
Instream Cover (%)	9	22
Eroding Banks (% of banks)	94	66
Water Velocity (cm/sec.)	11	9
Stream Width (m)	3.34	2.61
Stream Depth (cm)	13	16
Cobble Embeddedness (%)	25	50
Major Substrate Type	Large Rubble	Large Rubble
Periphyton Coverage (%)	80	80
Pool Riffle Ratio	80:20	50:50

Rabbit Creek

Rabbit Creek is an intermittent stream that flows into the South Fork Clearwater River at RK 11.3. The stream flows in a westerly direction through farmland and occasional steep canyon terrain. Riparian vegetation is good in most sections of this stream, except where the stream flows through a pasture at SK 5.1. When surveyed during August 1983, this stream was completely dry in the lower 4.8 kilometers and intermittent the rest of its length. One subyearling rainbow-steelhead was captured in the upper reaches of the creek at SK 5.5 (Table 55) and several possible hatchery fish were found in a pool at SK 5.6. Since only a trickle of water was available during the low flow period, attributes are reported but not elaborated on (Table 56). Water quality analysis indicated no major limitations to salmonid production (Table 54).

Table 54. Water sample analysis from one station on Rabbit Creek, tributary of S.F. Clearwater River Basin, Idaho, 1983.

Constituent	Station 1 Value
Calcium, Ca, mg/1	6.19
Magnesium, Mg, mg/1	1.99
Sodium, Na, mg/1	3.14
Potassium, K, mg/1	2.54
Chloride, Cl, mg/1	0.07
Carbonate, CO3, mg/1	Nil
Bicarbonate, HCO3, mg/1	0.53
Sulfate, SO4, mg/1	1
Nitrate, NO3, mg/1	0.01
Orthophosphate, PO4, mg/1	0.05
Total Residue, mg/1	118
Non-Filtered Residue, mg/1	1
pH	7.65

Table 55. Fish population statistics for rainbow-steelhead trout on Rabbit Creek, tributary of S.F. Clearwater River Basin, Idaho, 1983.

Biological Parameter	Units	Station 1 Value
Age 0+ Rainbow-Steelhead		
Density	fish/m^2	0.01
Standing Crop	kg/ha	0.38
Mean Weight	gm	3
Mean Length (TL-FL)	mm	59-57
Age 1+ Rainbow-Steelhead		
Density	fish/m^2	0
Standing Crop	kg/ha	0
Mean Weight	gm	0
Mean Length (TL-FL)	mm	0

Table 56. Measured physical parameters from one station on Rabbit Creek, tributary of S.F. Clearwater River Basin, Idaho, 1903.

Physical Parameter	Station 1 Value
Late Summer Stream Flow (m3/sec)	0.001
Annual Stream Flow Variation	0
Maximum Summer Temp. (C)	15
Instream Cover (%)	0.5
Eroding Banks (% of banks)	15
Water Velocity (cm/sec)	5
Stream Width (m)	1.56
Stream Depth (cm)	1
Cobble Embeddedness (%)	25
Major Substrate Type	Small Rubble
Periphyton Coverage (%)	100
Pool Riffle Ratio	40:60

Sally Ann Creek

Sally Ann Creek flows for 2.6 kilometers, of which 0.5 kilometers flow within the Nez Perce Reservation boundaries.This stream flows in a westerly direction to its confluence with the South Fork Clearwater River at RK 19. The stream originates in a wood lot and pasture environment and flows parallel to a county road for most of its length. A barrier exists at SK 1.8, which prevents upstream movement of adult anadromous fish. The major tributary of Sally Ann Creek is Wall Creek, which provides the majority of flow to the system during periods of low flow. Riparian vegetation is generally good except where the stream enters fenced pasture land. The sample station was located at SK 0.5. Results of the water quality analysis indicated no limiting factors for salmonid production (Table 57).

Station #l

One station was established on Sally Ann Creek to represent the reach below the barrier. This station was located at stream km, 0.5. The creek above the barrier tends to be intermittent and is not associated with the anadromous fishery.

Cutthroat trout, rainbow trout and sculpins were captured at station #1. The estimated standing crop of overyearling rainbow-trout was 38.63 kg/ha, with a density of 0.4 fish/m2. The estimated standing crop.of subyear ling rainbow-steelhead was 14.69 kg/ha with a density of 1.0 fish/m2 (Table 58). Cutthroat trout were captured in small numbers.

Late summer stream flow was 0.21 m3/sec,with moderate variation in annual stream flow. The maximum water temperature recorded was 16.7 C, which is below the lethal limit for trout production. Instream cover for overyearling rainbow-steelhead was 25% of the total area surveyed and 138 of the banks showed signs of erosion. Mean water velocity was 41 cm/sec, which is the value most preferred by overyearling rainbow-steelhead. The average stream width at low flow was 3.2 m. Mean water depth was 16 cm, slightly less than that preferred by juvenile rainbow-steelhead (Bovee 1978). Cobble embeddedness was 40%, which is probably limiting to salmonid production (Bjornn et al 1977). The major substrate was small boulder, which is preferred by juvenile rainbow-steelhead (Bovee 1978). Periphyton covered 100% of the substrate, indicating a productive stream. The pool riffle ratio of 40:60 indicated holding area present for juvenile salmonids. This reach of Sally Ann Creek was quite stable, with very good low riparian vegetation. Tall woody vegetation was lacking in some areas, although the understory vegetation generally formed a complete canopy over the stream (Table 59).

Table 57. Water sample analysis from one station on Sally Ann Creek, S.F. Clearwater River, Idaho, 1983.

Constituent	Station 1 Value
Calcium, Ca, mg/1	8.01
Magnesium, Mg, mg/1	2.38
Sodium, Na, mg/1	3.17
Potassium, K, mg/1	0.99
Chloride, Cl, mg/1	0.14
Carbonate, CO3, mg/1	0
Bicarbonate, HCO3, mg/1	0.73
Sulfate, SO4, mg/1	1
Nitrate, NO3, mg/1	<0.01
Orthophosphate, PO4, mg/1	0.05
Total Residue, mg/1	70
Non-Filtered Residue, mg/1	1
pH	8.05

Table 58. Fish population statistics for rainbow-steelhead trout on Sally Ann Creek, tributary of S.F. Clearwater River Basin, Idaho, 1983.

Biological Parameter	Units	Station 1 Value
Age 0+ Rainbow-Steelhead		
Density	fish/m^2	1.0
Standing Crop	kg/ha	14.69
Mean Weight	gm	1.4
Mean Length (TL-FL)	mm	52-49
Age 1+ Rainbow-Steelhead		
Density	fish/m^2	0.4
Standing Crop	kg/ha	38.63
Mean Weight	gm	15
Mean Length (TL-FL)	mm	117-109

Table 59. Measured physical parameters from one station on Sally Ann Creek, tributary of S.F. Clearwater River Basin, Idaho, 1983.

Physical Parameter	Station 1 Value
Late Summer Stream Flow (m3/sec)	.21
Annual Stream Flow Variation	Moderate
Maximum Summer Temp. (C)	16.7
Instream Cover (%)	25
Eroding Banks (% of banks)	13
Water Velocity (cm/sec)	41
Stream Width (m)	3.2
Stream Depth (cm)	16
Cobble Embeddedness (%)	40
Major Substrate Type	
Periphyton Coverage (%)	100
Pool Riffle Ratio	40:60

Wall Creek

Wall Creek flows for approximately 11.1 kilometers and is entirely off the reservation. Since the stream contributes the majority of flow to the Sally Ann system, a survey of this stream was undertaken. Wall Creek flows in a northwesterly direction and meets Sally Ann Creek at SK 1.4. The stream originates in pristine forest land and flows through a steep sided valley with grazing land intermixed. Water is diverted from the extreme upper reaches for stock water and irrigation by the Clearwater Water Assn. Several small dams could potentially hinder upstream movement of adult anadromous salmonids. However, the survey indicates that they are not within the zone of anadromous fish production. Above SK 3.2 only cutthroat trout were collected. Results of the water quality analysis indicated no limitations to salmonid production (Table 60).

Two stations were established on Wall Creek: station #l, representing the lower reaches of the creek, was located at SK 0.02, and station #2, representing the predominantly cutthroat trout habitat in the upper reaches, was located at SK 3.1.

Station #l

Bull trout, cutthroat trout, rainbow trout and sculpins were captured at this station. The estimated standing crop for overyearling rainbow-steelhead trout was 24.3 kg/ha, with a density of 0.2 fish/m2. Subyearling rainbow-steelhead standing crop was 5.2 kg/ha, with a density of 0.5 fish/m2 (Table 61).

Late summer stream flow was 0.13 m3/sec, with moderate annual variation in flow. The maximum water temperature was 18.9 C, below the lethal limit for salmonid production. Instream cover for overyearling rainbow-steelhead was 14% of the total area. Erosion of stream banks was 6% of the total bank length. Mean water velocity was 31 cm/sec, preferred by juvenile rainbow-steelhead trout (Bovee 1978). The average stream width at low flow was 3.56 m. Mean water depth was 12 CM, shallower than the optimum depths identified by Bovee (1978). Cobble embeddedness was 40%, a value which can affect salmonid production (Ejornn et al 977). Large boulders were the predominate substrate, identified as that most preferred by juvenile rainbow-sieelhead (Bovee 1978). Periphyton coverage was 20%, indicating lower primary productivity than most other streams on the reservation. The pool riffle ratio was 80:20, indicating abundanct pool habitat. This stream has excellent riparian over and understory and has excellent stability due to the large substrate in both the banks and the stream bottom (Table 62).

Station #2

Only cutthroat trout and sculpin were captured at station #2. The range for anadromous salmonids seems to end between these two stations,probably due to a lack of water for passage (Table 61).

Late summer flow was 0.12 m3/sec, with a moderate annual variation in flow. The maximum water temperature was 12.2 C, well within the limits for salmonid production. Thirteen percent of the area surveyed provided cover suitable for juvenile rainbow-steelhead trout. Only 11% of the banks showed signs of erosion. Mean water velocity was 28 cm/sec, an optimum value for juvenile rainbow-steelhead (Bovee 1978). The mean stream width at low flow was 2.95 m. Mean stream depth was 14 cm, below that which Bovee (1978) reported as most preferred by juvenile rainbow-steelhead. Cobble embeddedness was 40%, approaching that level which can limit salmonid production (Bjornn et al 1977). The major substrate available was large rubble, a size preferred by juvenile rainbow-steelhead trout (Bovee 1978). Periphyton coverage was 50%, indicating adequate productivity. Riffle habitat was predominant, indicated by a 10:90 pool riffle ratio. The habitat at this site is good with excellent tall riparian cover. However, there is a lack of low riparian vegetation since cattle graze in this area. The stream at this point is quite stable due to the extensive woody structure within the stream banks (Table 62).

Table 60. Water sample analysis from two stations on Wall Creek, Tributary to Sally Ann Creek, Idaho, 1983.

	Station	
	1	2
	Value	Value
Calcium, Ca, mg/1	7.48	7.21
Magnesium, Mg, mg/1	1.93	2.03
Sodium, Na, mg/1	3.36	3.01
Potassium, K, mg/1	0.78	0.88
Chloride, Cl, mg/1	0.15	0.18
Carbonate, CO3, mg/1	Nil	Nil
Bicarbonate, HCO3, mg/1	0.69	0.61
Sulfate, SO4, mg/.	1	1
Nitrate, NO3, mg/1	0.01	0.01
Orthophosphate, PO4, mg/1	0.05	0.05
Total Residue, mg/1	62	66
Non-Filtered Residue, mg/1	3	3
pH	7.82	7.94

Table 61. Fish population statistics for rainbow-steelhead trout on Wall Creek, tributary of Sally Ann Creek, Idaho, 1983.

Biological Parameter	Units	Station 1 Value	Station 2 Value
Age 0+ Rainbow-Steelhead			Cutthrout Trout Only
Density	fish/m^2	0.5	
Standing Crop	kg/ha	5.2	
Mean Weight	gm	1.0	
Mean Length (TL-FL)	mm	54-52	
Age 1+ Rainbow-Steelhead			
Density	fish/m^2	0.2	
Standing Crop	kg/ha	24.3	
Mean Weight	gm	13.6	
Mean Length (TL-FL)	mm	114-110	

Table 62. Measured physical parameters from two stations on Wall Creek, tributary of Sally Ann Creek, Idaho, 1983.

Physical Parameter	Station 1 Value	Station 2 Value
Late Summer Stream Flow (m3/sec)	0.13	0.12
Annual Stream Flow Variation	Moderate	Moderate
Maximum Summer Temp. (C)	18.9	12.2
Instream Cover (%)	14	13
Eroding Banks (% of banks)	6	11
Water Velocity (cm/sec)	31	28
Stream Width (m)	3.56	2.95
Stream Depth (cm)	12	14
Cobble Embeddedness (%)	40	40
Major Substrate Type	Large Boulder	Large Rubble
Periphyton Coverage (%)	20	50
Pool Riffle Ratio	80:20	10:90

Three Mile Creek

Three Mile Creek flows approximately 28.5 kilometers of which 6.9 kilometers are within the Nez Perce Reservation. The stream flows in a southeasterly direction and meets the South Fork of the Clearwater River at RK 14.5. The stream originates south of Grangeville, Idaho in forested land and flows north through Grangeville and adjacent agricultural land. Discharge from the Grangeville reclamation plant enters Three Mile Creek north of the town.The lower eight kilometers flow through a moderately steep canyon with limited access. A series of 2 M falls presents a potential barrier to upstream migration of adult anadromous salmonids at SK 9.5. Water quality analysis indicated no limitations to salmonid production, althrough elevated nutrients were noted (Table 63).

Three stations were established on Three Mile Creek: station #l, located at SK 1.3 and surveyed during summer 1982; station #2, located at SK 10.3 and sampled during summer 1983; and station #3, located at SK 18 and also sampled during summer 1983.

Station #1

Fish species present included rainbow-steelhead trout, juvenile chinook salmon, northern squawfish, chiselmouth, redside shiner, bridgelip sucker, speckled dace, and pauite sculpin. Northern squawfish was the most abundant species present and insufficient numbers of rainbow-steelhead were collected to estimate population size (Table 64).

Late summer flow was 0.09 m2/sec, with extreme annual variation in stream flow. The maximum water temperature was 24.4 C, which would be limiting for salmonid production. Instream cover for overyearling rainbow-steelhead was 7%. Approximately 15% of the stream banks showed signs of erosion. The mean water velocity was 15 cm/sec, which Bovee (1978) indicated to be optimum for juvenile rainbow-steelhead. The average stream width was 4.25 m at low flow. Mean water depth was 13 cm, which Bovee (i978) found to be below optimum for this species.Cobble embeddedness was 60% which Bjornn et al (1977) found could severely limit salmonid production. The major substrate was small rubble, which is near the optimal size for juvenile rainbow-steelhead (Bovee 1978). Periphyton coverage was 70%, indicating good productivity. The pool riffle ratio of 20:80 indicated a lack of holding area for overyearling rainbow-steelhead trout. The overall stability of this section of stream was poor due to flooding and constant erosion (Table 65).

Station #2

Rainbow-steelhead trout and speckled dace were the only species captured. Four overyearling rainbow-steelhead trout were collected but the sample was insufficient to calculate a population estimate. These fish were identified as hatchery fish due to their eroded fins and the fact that they were above the identified barrier to migration (Table 64).

Late summer stream flow was 0.16 m3/sec, with high variation in annual stream flow. The maximum water temperature was 21.1 C, near the maximum lethal temperature for salmonids. Instream cover for overyearling rainbow-steelhead was 26% of the area surveyed. Three percent of the stream banks surveyed exhibited erosional problems. The mean water velocity was 23 cm/sec, an optimal value as determined by Bovee (1978). Average stream width was 4.51 m at low flow. The mean stream depth was 16 cm, slightly less than optimal for juvenile rainbow-steelhead (Bovee 1978). Cobble embeddedness was 40%, possibly limiting salmonid production (Bjornn et al 1977). The major substrate was small boulder, an optimal size for rainbow-steelhead juveniles (Bovee 1978). Periphyton coverage was 0%, which indicated low productivity. The pool riffle ratio of 40:60 indicated a deficiency of pool habitat. The stability of the banks and the stream in general was very good since riparian vegetation was well developed and the cobble-boulder substrate provided a sturdy stream bed (Table 65).

Station #3

Only speckled dace were captured and no salmonids were seen (Table 64).

The 1 ow summer flow was 0.18 m3/sec, with high variation in annual stream flow. The maximum water temperature was 12.2 c, well within the limits for rainbow-steelhead. Instream cover was 68% of&he area surveyed and 63% of the stream banks observed showed signs of erosion. Mean water velocity was 33 cm/sec, an optimal value for rainbow-steelhead juveniles (Bovee stream depth was 16 cm, a depth Bovee (1978) found to be less than optimal. Cobble embeddedness was 40%, indicating a potential problem with salmonid production (Bjornn et al 1977). The major substrate was loose gravel, which would make good spawning substrate, but was below optimum size for rearing of juvenile rainbow-steelhead (Bovee 1978). Periphyton coverage was 80%, indicating good productivity. The pool riffle ratio of 30:70 indicated a lack of holding area for juvenile rainbow-steelhead. The general stability of the stream, and its banks, was good due to grasses and woody plants even though the surrounding substrate was soil (Table 65).

Table 63. Water sample analysis from three stations on Threemile, S.F. Clearwater River, Idaho, 1982, 1983.

Constituent	Station 1 Value	Station 2 Value	Station 3 Value
Calcium, Ca, mg/1	18.7	16.6	16.5
Magnesium, Mg, mg/1	7.2	6.0	5.8
Sodium, Na, mg/1	14.6	19.12	19.7
Potassium, K, mg/1	3.9	3.6	4.5
Chloride, Cl, mg/1	0.24	0.48	0.42
Carbonate, CO3, mg/1	<0.22	0	0
Bicarbonate, HCO3, mg/1	1.81	1.63	1.47
Sulfate, SO4, mg/1	3	4	3
Nitrate, NO3, mg/1	0.08	4.70	4.48
Orthophosphate, PO4, mg/1	0.50	1.72	2.14
Total Residue, mg/1	451	222	180
Non-Filtered Residue, mg/1	16	16	16
pH	7.4	8.1	7.9

Table 64. Fish population statistics for rainbow-steelhead trout on Threemile Creek, tributary of S.F. Clearwater River Basin, Idaho, 1982, 1983.

Biological Parameter	Units	Station 1 Value	Station 2 Value	Station 3 Value
Age 0+ Rainbow-Steelhead		RB Present	RB Present	
Density	fish/m^2			0
Standing Crop	kg/ha			0
Mean Weight	gm			0
Mean Length (TL-FL)	mm			0
Age 1+ rainbow-Steelhead		RB Present	RB Present	
Density	fish/m^2			0
Standing Crop	kg/ha			0
Mean Weight	gm			0
Mean Length (TL-FL)	mm			0

Table 65. Measured physical parameters from three stations on Threemile Creek, tributary of S.F. Clearwater River Basin, Idaho, 1982, 1983.

Physical Parameter	Station 1 Value	Station 2 Value	Station 3 Value
Late Summer Stream Flow (m3/sec)	0.09	0.16	0.18
Annual Stream Flow Variation	Extreme	Extreme	Extreme
Maximum Summer Temp. (C)	24.4	21.1	12.2
Instream Cover (%)	7	26	68
Eroding Banks (% of banks)	15	3	63
Water Velocity (cm/sec)	15	23	33
Stream Width (m)	4.25	4.51	3.47
Stream Depth (cm)	13	16	16
Cobble Embeddedness (%)	60	40	40
Major Substrate Type	Small Rubble	Small Boulder	Loose Gravel
Periphyton Coverage (%)	70	0	80
Pool Riffle Ratio	20:80	40:60	30:70

Whiskey Creek

Whiskey Creek is 37.9 kilometers long,of which 1.2 kilometers flow within the Nez Perce Reservation. The stream flows in a southerly direction to its confluence with Orofino Creek at RK 6.4. The stream originates in mixed forest and grazing land east of Orofino, Idaho and flows parallel to a highway for 2.4 kilometers where it drops quickly into an extremely steep walled canyon of steep gradient. Access to the creek in the canyon is limited, but several barriers to anadromous salmonid migration were identified. These barriers consisted of several falls and cataracts located within the canyon proper. The lower 1.5 km of the stream flows through residential and commercial property. Major tributaries of Whiskey Creek are Deer Creek, Falls Creek and Crooked Creek. The headwaters of Whiskey Creek and Crooked Creek exhibit the effects of logging and grazing. Water quality analysis did not indicate any limiting factors to salmonid production (Table 66).

Three stations were sampled on Whiskey Creek during the summer of 1983: station #l, #2, and #3, located at SK 0.8, 17.7 and 20.9, respectively.

Station #l

Rainbow-steelhead trout, sculpin and speckled dace were captured at this station. The overyearling rainbow-steelhead standing crop was 39.8 kg/ha, with a density of 0.2 fish/m2. Estimated subyearling rainbow-steelhead standing crop was 14.9 kg/ha, with a density of 0.7 fish/m2 (Table 67).

Late summer stream flow was 0.46 m3/sec, with moderate annual variation in stream flow. The maximum water temperature was 15.5 C, well below the lethal limit for salmonid production. lnstream cover for overyearling rainbow-steelhead was 19% of the total area surveyed and 14% of the stream banks exhibited signs of erosion. Mean water velocity was 37 cm/sec, which is among the optimum values for juvenile rainbow-steelhead (Bovee 1978). The average stream width at low flow was 5.0 m. Mean water depth was 25 cm, slightly below that most preferred by rainbow-steelhead juveniles (Bovee 1978). Cobble embeddedness was 40%, possibly limiting to salmonid production (Bjornn et al 1977). The major substrate was small boulder, a size preferred by juvenile rainbow-steelhead (Bovee 1978). Periphyton coverage was l00%, indicating good stream productivity. The pool riffle ratio was 40:60, indicating available holding area for juvenile rainbow-steelhead. The general stability of Whiskey Creek was good due to good overstory riparian vegetation and banks composed of large substrate (Table 68).

Station #2

Rainbow-steelhead trout, brook trout, and speckled dace were captured at station #2, above the migration barriers. Estimated standing crop of overyearling rainbow-steelhead was 9.18 kg/ha, with a density of 0.04 fish/m2. No subyearling rainbow trout were collected at this station (Table 67).

Late summer stream flow was 0.13 m3.sec,with moderate variation in annual stream flow. Maximum water temperature during low flow was 17.2 C, below the lethal limits for rainbow trout. Cover for overyearling rainbow-steelhead trout was 73% and bank erosion was 3%. Mean water velocity was 18 cm/sec, less than that most preferred by juvenile rainbow-steelhead trout (Bovee 1978). The average stream width at low flow was 3.8 m. The mean water depth was 20 cm, slightly less than optimum for this species (Bovee 1978). Cobble embeddedness was 40%, which can limit salmonid production (Bjornn et al 1977). The major substrate was small rubble, which is near optimum for juvenile rainbow-steelhead (Bovee 1978). Periphyton coverage was 75%, indicating good productivity. The pool riffle ratio was 80:20, indicating substantial holding area for juvenile rainbow-steelhead. Considering the excellent riparian cover and large substrate present in the stream banks, the stability of the stream at this station was excellent (Table 68).

Station #3

Rainbow-steelhead trout, brook trout, and speckled dace were captured at this station. Insufficient numbers of rainbow trout were caught to generate a population estimate (Table 67).

Late summer stream flow was 0.13 m3/sec, with moderate variation in annual stream flow. The maximum water temperature was 16.7 C, below the lethal limit for salmonids. Instream cover for overyearling rainbow-steelhead was 29% of the available habitat. Twenty percent of the stream bank surveyed showed signs of erosion. Mean water velocity was 16 cm/sec, a value most preferred by rainbow-steelhead trout (Bovee 1978). The average stream width during low flow was 3.8 m. Mean water depth was 22 cm, slightly less than that preferred by the species (Bovee 1978), Cobble embeddedness was 60%, which can limit salmonid production (Bjornn et al 1977). The major substrate was sand, which is not preferred by juvenile rainbow-steelhead trout (Bovee 1978). Periphyton coverage was 40%, indicating less productivity than the two stations. The pool riffle ratio of 80:20, indicated an abundance of holding area for larger fish. The stability of this station was good due to thick riparian growth. Road construction has produced erosion just upstream from this station (Table 68).

Table 66. Water sample analysis from three stations on Whiskey Creek, Tributary to Orofino Creek, 1983.

Constituent	Station 1 Value	Station 2 Value	Station 3 Value
Calcium, Ca, mg/l	22.0	19.9	18.2
Magnesium, Mg, mg/l	8.2	7.4	6.3
Sodium, Na, mg/l	12.3	11.5	9.8
Potassium, K, mg/l			
Chloride, Cl, mg/l	0.86	0.09	0.08
Carbonate, C03, mg/l	0	0	0
Bicarbonate, HC03, mg/l	0.86	0.61	0.94
Sulfate, S04, mg/l	1	1	1
Nitrate, N03, mg/l	0.33	0.01	0.01
Orthophosphate, P04, mg/l	0.03	0.01	0.01
Total Residue, mg/l	96	92	126
Non-Filtered Residue, mg/l	<1	<1	1
pH	7.98	7.74	7.61

Table 67. Fish population statistics for rainbow-steelhead trout on Whiskey Creek, tributary to Orofino Creek, Idaho, 1983.

Biological Parameter	Units	Station 1 Value	Station 2 Value	Station 3 Value
Age 0+ Rainbow-Steelhead				
Density	fish/m2	0.7	0	RB Present
Standing Crop	kg/ha	14.9	0	
Mean Weight	gm	2.3	0	
Mean Length (TL-FL)	mm	59-56	0	
Age 1+ Rainbow-Steelhead				
Density	fish/m2	0.2	0.04	RB Present
Standing Crop	kg/ha	39.8	9.18	
Mean Weight	gm	18.1	21.7	
Mean Length (TL-FL)	mm	130-123	135-128	

Table 68. Measured physical parameters from three stations on Whiskey Creek, Tributary of Orofino Creek, Idaho 1983.

Physical Parameter	Station 1 Value	Station 2 Value	Station 3 Value
Late Summer Stream Flow (m3/sec)	0.46	0.13	0.13
Annual Stream Flow Variation	Moderate	Moderate	Moderate
Maximum Summer Temp. (C)	15.5	17.2	16.7
Instream Cover (%)	19	73	29
Eroding Banks (% of banks)	14	3	20
Water Velocity (cm/sec)	37	18	16
Stream Width (m)	5.08	3.8	3.8
Stream Depth (cm)	25	20	22
Cobble Embeddedness (%)	40	40	60
Major Substrate Type	Small Boulder	Small Rubble	Sand
Periphyton Coverage (%)	100	75	40
Pool Riffle Ratio	40:60	80:20	80:20

Willow Creek

Willow Creek flows intermittently for approximately 9.7 kilometers within the Nez Perce Reservation. The stream flows in a southeasterly 'direction and discharges into the upper reacher; of Lawyers Creek at (SK 4.8). Two major tributaries of Willow Creek (North Fork and South Fork) converge to form the mainstem, which flows for 3.7 kilometers. The two tributaries are intermittent during late summer and their flows reflect local precipitation. Riparian vegetation is lacking throughout the system due to heavy grazing activities. Water quality analysis indicated no limitations to salmonid production (Table 69).

Two stations were established on Willow Creek: station #1, located at SK 0.8 and surveyed during summer 1982; and station #2, located at SK 2.9 and surveyed during summer 1983.

Station #1

Fish composition consisted of rainbow-steelhead trout and speckled dace. Estimated standing crop of overyearling rainbow-steelhead was 53.2 kg/ha, with a density of 0.07 fish/m2. Some Of these may have been of hatchery origin due to the supplemental put and take fishery, managed by the Idaho Fish and Game Department, which occurs in this area on a yearly basis. The stream is located above a partial barrier on Lawyers Creek (Kucera et al 1983) (Table 70).

The low summer stream flow was 0.07 m3/sec, with moderate variation in annual stream flow. The maximum water temperature was 26.7 C, which can be lethal to rainbow-steelhead trout. Instream cover for overyearling fish was 11.5% of the total area surveyed. Eroding banks were identified in 69% of the total stream bank length. Mean water velocity was 11 cm/sec, slightly below the optimum for rainbow-steelhead juveniles (Bovee 1978). The average stream width during low flow was 2.82 m. Mean water depth was 23 cm, slightly below the optimum described by Bovee (1978).Cobble embeddedness was 608, which can severely limit salmonid production (Bjornn et al 1977). The major substrate was small rubble, which was identified as near optimum for rainbow-steelhead juveniles by Bovee (1978). Coverage of the substrate by periphyton was 40%, indicating fair productivity. The pool riffle ratio was 60:40, near optimum for overyearling rainbow-steelhead rearing conditions. The general stability of the banks and stream in general was fair due to the grazing activities (Table 71).

Station #2

Rainbow-steelhead trout and speckled dace were captured at station #2. The estimated standing crop of overyearling rainbow-steelhead trout was 51.9 kg/ha, with a density of 0.17 fish/m2. No subyearling rainbow-steelhead were captured. These fish were most likely fish of hatchery origin as the Idaho Fish and Game Department stocks this stream on a regular basis (Table 70).

Late summer stream flow was calculated at 0.08 m3/sec, with moderate annual variation in stream flow. The maximum water temperature was 22.2 C, approaching the maximum lethal limit for salmonids.

Eroding banks were 38% of the total stream banks surveyed. Mean water velocity was 19 cm/sec, an optimum value for rainbow-steelhead juveniles (Bovee 1978). Average stream width was 2.62 m during low flow. Mean water depth was 17 cm, slightly below optimum for this species (Bovee 1978). Cobble embeddedness was 50%, which can severely limit salmonid production (Bjornn et al 1977). The major substrate was small rubble, which is smaller than optimum for rainbow-steelhead juveniles (Bovee 1978). Periphyton coverage was 08, indicating a lack of productivity or an extremely high sedimentation rate. The pool riffle ratio of 60:40 indicated a moderate value of the annual stream flow variation. Bank and stream stability was poor throughout this area due to overgrazing near stream banks and erosion (Table 71).

Table 69. Water sample analysis from two stations on Willow Creek, Tributary to Lawyers Creek, Idaho, 1982,83.

Constituent	Station 1 Value	Station 2 Value
Calcium, Ca, mg/l	3.93	15.27
Magnesium, Mg, mg/l	1.08	5.20
Sodium, Na, mg/l	3.26	7.06
Potassium, K, mg/l	0.94	3.24
Chloride, Cl, mg/l	0.02	0.09
Carbonate, CO3- mg/l	<0.22	0.16
Bicarbonate, HCO3, mg/l	0.44	1.14
Sulfate, S04, mg/l	1	3
Nitrate, N03, mg/l	<0.01	0.04
Orthophosphate, P04, mg/l	<0.01	0.01
Total Residue, mg/l	65	212
Non-Filtered Residue, mg/l	<0.10	10
PH	7.3	7.7

Table 70. Fish population statistics for rainbow-steelhead trout on Willow Creek, tributary of Lawyers Creek, Idaho, 1982, 1983.

Biological Parameter	Units	Station 1 Value	Station 2 Value
Age 0+ Rainbow-Steelhead			
Density	fish/m2	0	0
Standing Crop	kg/ha	0	0
Mean Weight	gm	0	0
Mean Length (TL-FL)	mm	0	0
Age 1+ Rainbow-Steelhead			
Density	fish/m2	0.07	0.17
Standing Crop	kg/ha	53.2	51.9
Mean Weight	gm	66.5	33.6
Mean Length (TL-FL)	mm	--	150-142

Table 71. Measured physical parameters from two stations on Willow Creek, tributary of Lawyers Creek, Idaho, 1982, 1983.

Physical Parameter	Station 1 Value	Station 2 Value
Late Summer Stream Flow (m3/sec)	0.07	.08
Annual Stream Flow Variation	Moderate	Moderate
Maximum Summer Temp. (C)	26.7	22.2
Instream Cover (%)	11.5	.06
Eroding Banks (8 of banks)	69	38
Water Velocity (cm/sec)	11	19
Stream Width (m)	2.82	2.62
Stream Depth (cm)	23	17
Cobble Embeddedness (%)	60	50
Major Substrate Type	Small Rubble	Small Rubble
Periphyton Coverage (%)	40	0
Pool Riffle Ratio	60:40	60:40

ENHANCEMENT RECOMMENDATIONS

The major problem in all the lower Clearwater River Basin watersheds is extreme annual variation in streamflow. All the watersheds investigated were characterized by excessively high flows of short duration during spring runoff and intensive precipitation periods and by very low stream flows during the dry summer and fall periods. Excessively high flows over short time periods have caused flooding and high rates of channel re-structuring to accommodate large volumes of high velocity runoff. Rates of scouring and deposition are relatively high and stream banks are relatively unstable.

The major component of stream flow which is related to stream degradation is energy. A given amount of precipitation in a watershed provides a given amount of potential stream flow energy available in that watershed. The rate at which this energy is released from the watershed is directly related to the condition of that watershed. A pristine watershed releases its stream flow energy in a more or less uniform manner over time. This enables a small stream with flow obstructions to convey this water from the watershed without excessive scouring. As a watersheds capability to reservoir precipitation is decreased; stream flow energy is released over a shorter time period. To accommodate these higher short term releases,stream channels must enlarge to reach a hydraulic equilibrium. This results in the common condition where low flows only partially utilize available stream channel area and physical habitat for fish (i.e., depth, cover, etc.) is absent.

As is evident, the management of the watersheds capability to retain water is of critical importance to the condition of its associated streams. Short of managing the watershed for water retention, several "band aid" enhancement activities designed to withstand present watershed conditions can help improve stream habitat.

To address the lack of physical habitat for anadromous salmonids, instream structures designed to withstand present stream energy regimes can improve this habitat for anadromous salmonids in the lower Clearwater Basin. These structures, properly designed, could also increase the duration of streamflow releases, thereby reducing the peak stream energy potential.

Another effect of high energy release, in addition to the condition of the structural instream habitat, is the addition of sediment to the stream channel. This sediment introduction can be reduced by either stabilizing the sediment sources (i.e., streambanks, etc.) with riparian vegetation or physical means by trapping the sediment with basins upstream from the zone to be enhanced.

The following recommendations are presented as a guideline to instream enhancement of selected streams within the lower

Clearwater Basin surveyed **during 1983.** They should provide a general outline from which specific enhancement plans can be derived.

Bedrock Creek

Problem: Extreme annual streamflow variation; low summer flow; and lack of pool habitat.

The Bedrock Creek watershed is characterized by extremely steep slopes which have sparse vegetation on the southern exposures. The upper reaches of Bedrock Creek flow through agricultural land and lack well developed riparian vegetation. These two conditions result in extreme variation in annual stream flow; extremely high spring run off and low flow during the summer months. The extreme spring runoff has caused most debris, boulders, and other instream structures to be washed out of the system. Thus, the stream has developed flood plains in the middle and low reaches which inhibit riparian vegetation growth that would shade the stream at the reduced flow stage.

Solution: Riparian enhancement on agricultural land in the upper watershed would decrease the rate of water runoff in the spring. Additional riparian enhancement is needed in the vicinity of Louse Creek. Since the watershed has a very steep gradient, stream flow velocity in Bedrock Creek can be controlled best by placing instream deflectors such as log and boulder dams,boulder clusters, woody debris such as stumps and logs, etc., throughout the stream system. These structures would also contribute to the development of instream cover. After the conditions in the upper reaches have been addressed, the lower reaches of Bedrock Creek can be rechannelized (meandering path) and riparian vegetation can be developed along the new stream banks to shade the stream and provide overhead cover.

Predicted results:

1. Decreased annual variation in flow.
2. Increased low summer flow.
3. Increased cover for juvenile salmonids.
4. Increased pool habitat.

Specific activities:

1. Approximately 8 km of riparian enhancement.
2. Placement of approximately 176 (every 50 m) velocity check structures.
3. Rechannelize approximately 1.2 km of stream in the lower reaches.

Land ownership:

100% private

Big Creek

Problem: Moderate variation in annual stream flow; partial migration barriers.

Major enhancement to decrease variation in annual stream flow is probably not economically feasible since this stream has limited access in the canyon area. However, development of riparian vegetation can be conducted in the upper reaches of agricultural land. There are a series of small falls within k 0.4 on Big Creek, the largest of which is a natural rock formation. In addition, a small falls was created as a result of railroad trestle construction. Since these barriers are not complete migration obstructions, they should not be high priority.

Predicted results:

1. Decreased variation in annual stream flow.
2. Improve upstream passage.

Specific activities:

1. Approximately 4.8 km of riparian enhancement.
2. Remove or modify several partial passage barriers within approximately 3.2 km of stream.

Land ownership:

100% private

Butcher Creek

Problem: Extreme annual stream flow variation; low summer flow; high summer water temperatures; and lack of pool habitat.

Because of excessive grazing, the entire length of Butcher Creek has poor riparian vegetation, principally in the upper and lower reaches. This condition is a principal cause for extreme variation in annual stream flow. High spring runoff' has scoured the middle and lower reaches of the stream leaving rocky floodplain areas and little pool habitat area. The lack of shading has resulted in high water temperatures, especially toward the stream mouth.

Solution: Extensive riparian enhancement is necessary in the lower 0.8 km of stream and in the headwaters, which flow through agricultural land. Instream deflector structures, such as log and rock dams, boulder groups, and woody debris, are needed in the middle and lower reaches of the stream to reduce water velocity and provide instream cover. The lower reach, including the floodplain, needs rechannelization (meanders) and bank stabilization, in addition to the aforementioned riparian enhancement.

Predicted results:

1. Decreased variation in annual stream flows.
2. Decreased summer water temperatures.

3. Increased cover and pool habitat.

Specific **activities:**

1. Approximately 8 km of riparian enhancement.
2. Placement of approximately 50 instream deflectors.
3. Stream channelization of 0.8 km.

Land ownership:

100% private

Water rights:

0.38 cfs

Catholic Creek

Problem: Extreme annual stream flow variation; low summer flow; lack of instream cover; eroding banks; and lack of pool habitat.

Catholic Creek is subject to excessive grazing activity in the lower reaches and intensive agricultural activity in the extreme headwaters. The middle section of the creek is within a steep canyon with well developed riparian vegetation.

Solution: Riparian enhancement is needed in the uppermost 4.8 km of stream in agricultural land and the lower 3.2 km where grazing activity is present. Instream structures and woody debris are recommended for the lower 4.8 km of stream. In addition pool construction aside from the instream structures is advised.

Predicted results:

1. **Decrease** in peak runoff.
2. Increased instream cover.
3. Stabilized banks.
4. Increased pool habitat.

Specific activites:

1. Approximately 6.4 km of riparian enhancement.
2. Placement of 90 instream check structures at points of high

water velocity.

3. Construction of 10 pools within the lower 4.8 km of stream.

Land ownership:

130% private

Corral Creek

Problem: Instream cover: lack of pool habitat; moderate annual stream flow variation.

Corral Creek is not as severely degraded as many streams on the Nez Perce Reservation. The lower 3.2 km show signs of grazing activity while the upper reaches have been logged.

Solution: Since the discharge from Corral Creek is small, adult fish can probably navigate only the lower 3.2 km. Therefore, it is recommended that any enhancement be limited to this area. Instream structures, and debris such as stumps and logs will provide additional cover and pool habitat. Pool construction is possible in many locations though the bedrock layer is not very deep.

Predicted results:

1. Additional instream cover.
2. Additional pool habitat.
3. Reduced stream velocity (energy),

Specific activities:

1. Approximately 35 instream structures.
2. Pool construction within 8 km stream section.
3. Debris addition for 3.2 km.

Land ownership:

5% State

15% Nez Perce Tribe

Cottonwood Creek

Problem: Extreme annual stream flow variation; lack of pool habitat: high summer water temperatures: lack of instream cover; and sedimentation.

Cottonwood Creek has poorly developed riparian vegetation throughout the entire system. This condition results in extreme variation in stream flows; high spring runoff and low summer flow. Farmland in the upper reaches of Cottonwood Creek have very high rates of soil erosion. Due to the high energy and scouring action during periods of peak runoff, little pool habitat is available in the lower 10.4 km of stream. The presence of a 9.8 m of falls at SK 10.4 completely prohibits any upstream movement by anadromous fish beyond this point.

Solution: Major rejuvination of Cottonwood Creek will be necessary to reestablish anadromous fish runs. Extensive riparian enhancement is needed along the entire length of stream, particularly in the upper reaches of agricultural land. The lower 19.4 km are eroded by floods leaving an established floodplain. Rechannelization with bank reinforcement and riparian rejuvenation of vegetation is necessary in the lower 10.4 km. Instream deflectors and dam and debris placement is recommended to increase cover for juvenile salmonids.

Predicted results:

1. Decreased water temperatures.
2. Increased pool habitat.
3. Decreased annual **stream** flow variation.
4. Decreased sedimentation.
5. Increased instream cover.

Specific activities:

1. Approximately 25.7 km of riparian enhancement.
2. Silt collection basins (15) on key tributaries.
3. Check dam construction and pool excavation for the lower 6.5 km.

Land ownership:

99% Private

1% Nez Perce Tribe

Water rights:

0.91 cfs

Jim Ford Creek

Problem: Moderate annual flow variation; lack of instream cover; high water temperatures; and lack of pool habitat.

The major problem confronting Jim Ford Creek is its shallow channel, which expands laterally with increased flow. Thus, during periods of low flow, the channel has very restricted riparian cover or overstory. This condition is prevalent in the middle reach of the stream. Since scouring does occasionally take place during portions of high flow, instream cover (boulders, debris, etc.) is limited.

Solution: The habitat above Jim Ford falls is heavily silted and prone to erosion. Riparian enhancement on all tributaries on the stream is recommended. In addition, bank stabilization measures are needed to curb erosion. The stream below the falls, which is available to anadromous fish, is prone to flooding. Velocity check structures and adjacent pool habitat are recommended from this point to the mouth. The area where floodplains exist, rechannelization of the stream, bank stabilization, and enhancement of the riparian zone is recommended.

Predicted results:

1. Decreased sedimentation in the headwaters.
2. Decreased water temperatures.

3. Increased pool habitat.

4. Decreased in peak flows in velocities.

Specific activities:

1 Riparian enhancement for 11.2 km.

2. Construction of 40 pools.

Land ownership:

15% Nez Perce Tribe

22% State Land

63% Private

Water Rights:

13.77 cfs

13 cfs (Grass Hopper Creek)

Lawyers Creek (Headwaters)

Problem: Sedimentation

The major problem confronting the headwaters of Lawyers Creek is bank erosion caused by a reduction in riparian vegetation and grazing activites.

Solution: Riparian enhancement is recommended throughout this section of Lawyers Creek. Fragile top soil is subject to heavy erosion and trampling by cattle. Both small woody vegetation and overstory would protect stream banks and provide shading. As this section of stream is probably not utilized by anadromous fish, instream habitat restoration is not recommended at this time.

Predicted results:

1. Decreased sedimentation.
2. Increased channel stability.

Specific activities:

1. Riparian enhancement for 6.4 km.

Land ownership:

100% Private

Lolo Creek

Problem: High water temperatures in lower reaches; sedimentation; degraded riparian zone; and impediment to migration.

The lower reaches of Lolo Creek, off the Clearwater National Forest, has limited enhancement potential due to its size and inaccessability. The primary problems identified in this section were lack of premium spawning substrate, siltation, and high summer water temperatures, none of which can be addressed at this point. The upper 6.4 km below the Forest boundary provide spawning habitat for salmonids although excessive silt is present in places. From the forest boundary to the mouth of Musselshell Creek, the stream shows signs of heavy siltation (#3) , and is the location of Lolo Falls. The remaining streams (#4-7)are impacted by road construction and mining activities. Due to its location in the upper watershed and good access on Forest Service roads, this section of stream is the logical area for major enhancement activities.

Solution: The addition of instream cover and riparian enhancment is recommended on Lolo Creek near the mouth of Yakus Creek. Instream scouring structures could be installed in the section between the mouth of Musselshell Creek and the forest boundary. However, decreased sediment load from Musselshell Creek should be the primary objective. Additional blasting of Lolo Falls is recommended to provide better access to the upper system. Lolo

Creek, from the mouth of Musselshell Creek to the mouth of Yoosa Creek, is subject to excessive sediment deposits, and lacks instream cover and pool habitat. Scouring structures such as **check dams,** large boulder groups, and a greatly increased amount of secured cedar stump wads and logs would improve this section of stream. In addition, heavy vegetative cover should be planted on slopes of Forest Service road (# 100) where necessary to decrease erosion and revegetate the south bank of Lolo Creek where necessary.

Predicted results:

1. Increased clean substrate.
2. Increased cover.
3. Decreased strtamside erosion.

Specific activities:

1. Riparian enhancement.
2. Woody debris
3. Instream structures

Land ownership:

30% BLM

53% Forest Service

19% State

1.0% Private

Water rights:

5.14 cfs

Yakus Creek

Problem: Sedimentation (upper reaches); lack of instream cover and bank erosion (lower reaches); and lack of pool habitat.

The upper reaches of Yakus Creek are subject to sedimentation from logging road construction and other logging activities. Otherwise, the stream is in good condition.

Solution: Installation of check structures and sediment collectors is recommended on small side streams which receive high sediment loads. Riparian enhancement and bank stabilization is recommended in the lower reaches of this system. In addition, check dams and the introduction of woody debris would increase instream cover and pool habitat.

Predicted results:

1. Decrease sedimenation in upper reaches.
2. Decrease bank erosion,
3. Increased instream cover and pool habitat in lower reaches.

Specific activities:

1. Installation of sediment collectors (14) in key tributaries.
2. Riparian enhancement of lower 3.2 kilometers.
3. Check dam construction(15) on lower 3.2 kilometers.

Land ownership:

50% USFS

15% State

35% Private

Musselshell Creek

Problem: Sedimentation: impediments to migration; and high water temperature.

Musselshell Creek has an exceptionally high rate of sedimentation transport which is attributed to intensive logging in the upper drainage. Road construction paralleling the upper 2.3 of this construction paralleling the upper 2/3 of this stream also provide a sediment source. Riparian vegetation while sufficient in the upper and lower reaches, is lacking in the vicinity of the Musselshell work station. Several debris dams are located in the lower 2 miles of stream which impede potential upstream migration by adult anadromous salmonids. High water temperatures found in the lower reaches of Musselshell Creek are primarily due to lack of riparian vegetation.

Solution: Riparian enhancement is recommended in the vicinity of Musselshell work station. Check dams or siltation collectors are recommended on all small tributaries to upper Musselshell Creek. The removal of debris dams in the lower reaches should facilitate upstream migration by salmon and steelhead. In addition to these recommendations, scouring structures placed in mainstem Musselshell Creek should provide clean spawning gravels. The spawning channel and pond located adjacent to Musselshell work station should be opened for rainbow-steelhead or salmon propagation.

Predicted results:

1. Decreased sediment imput.
2. Decreased water temperature.
3. Improved upstream access for salmonids.

Specific activities:

1 Riparian enhancement - 2 miles
2. 'Scouring structures - 50
3. Sediment collectors - 100
4. Dam removals - 3
5. Spawning channel and pond clean up.

Land ownership:

90% USFS

10% Private

Water rights:

2C cfs (mining)

Browns Creek

Problem: Sedimentation and bank erosion.

The entire Browns Creek watershed has been either heavily grazed by cattle or logged intensively. Both of these activities have led to large amounts of sedimentation in Browns Creek. When high rates of precipitation occur renewed erosion and subsequent sedimentation take place.

Solution: Major riparian enhancement is recommended for the entire length of Browns Creek. Check structures to catch sediment runoff should be placed on all applicable tributaries to the main stream. These activities will be especially useful in the upper drainage where logging activities and subsequent skid trails and roads pose major erosional problems. The mainstem is in need of bank stabilization measures as well as riparian vegetation. Scouring structures, such as check dams and/or boulder groups, are recommended in this mainstem reach to provide clean spawning gravels for adult rainbow-steelhead.

Predicted results:

1. Decreased sediment imput.
2. Decreased bank erosion.
3. Increased channel stability.

Specific activities:

1. Riparian enhancement - 24.1 km
2. Sediment check structures - 50.
3. Scour structures - 35.

Land ownership:

10% Forest Service

10% State

80% Private

Water rights:

0.26 cfs

Eldorado Creek

Problem: Sedimentation; barriers to migration and lack of instream cover.

Eldorado Creek contains a large amount of heavy sand bedload. The majority of this sandy material is probably of natural origin (Espinosa, personal communication) and will always be present in the upper reaches. The major limitation to salmonid production in Eldorado Creek is a series of cascades, a sheer 3.6 m falls and a rock fall that inhibit upstream movement of adult salmonids. Instream cover in stream reaches where water velocity is sufficient to scour the substrate is lacking.

Solution: Extensive blasting of both the cascades and sheer falls would create stair steps for migrating adult salmonids in the lower reach of Eldorado Creek. In addition, blasting or physical removal of large boulders above Eldorado falls are necessary for upstream movement. Instream scour structures should be placed in areas where water velocity is sufficient. This would provide clean spawning gravel for adult salmonids.Check dams and boulder groups, in addition to the above mentioned scouring structures, would provide additional cover in these areas for juvenile salmonids. Sedimentation traps are recommended on all west flowing tributaries.

Predicted results:

1. Increased clean gravel for salmonid reproduction.

2. Increased instream cover.

3. Opening of lower stream to passage by adult salmonids.

Specific activities:

1. Scouring structures - 40
2. Additional instrea cover - 100
3. Blasting operations - 2
4. Boulder removal -1

Land ownership:

100% USFS

Yoosa Creek

Yoosa Creek is in relatively good condition. Little physical enhancement in recommended with the exception of increased vegetation adjacent to forest road 103 and continued maintenance of associated drain structures.

Maggie Creek

Problem: Extreme annual stream flow variation;high water temperatures: lack of instream cover; bank erosion; sedimentation; and lack of pool habitat,

High spring runoff and the related erosion and scouring activity are the primary problems on Maggie Creek. Scouring has displaced much of the woody debris and filled in natural pool habitat. Lack of overstory and riparian vegetation in the lower reaches has led to high summer water temperatures.

Solution: Check dams, instream deflectors, and related pool habitat enhancement is recommended for the lower 12.9 km of Maggie Creek. Enhancement of stream side riparian vegetation in the lower 3.2 km of stream is greatly needed. Intermittent riparian enhancement is recommended for the next 9.6 km in locations where floodplains exist. The addition of anchored woody debris (i.e., stumps, logs) is recommended throughout the system. Pool construction is especially needed in the lowest 3.2 km of stream.

Predicted results:

1. Additional instream cover.
2. Additional pool habitat.
3. Reduced stream velocity (energy).
4. Decreased water temperatures.

5. Reduced erosion and sedimentation.

Specific activites:

1. Pool habitat construction - 3.2 km (20).
2. K dams, log structures - 30.
3. Riparian vegetation - 9.6 km

Water rights:

0.25 cfs

Mission Creek (Upper)

Problem: Bank erosion; sedimentation; high water temperatures; instream cover; and lack of pool habitat.

Upper Mission Creek is subject to cattle grazing activity. Degradation of riparian vegetation has left stream banks susceptible to erosion. Lack of woody debris and large substrate restricts the formation of pool habitat.

Solution: Extensive riparian enhancement, both short woody plants and tall overstory is recommended. Small instream structures to decrease stream velocity and form pool habitat are needed. Additional woody debris throughout the system is recommended to provide cover.

Predicted results:

1. Decreased bank erosion and sedimentation.
2. Lower water temperatures.
3 Increased instream cover and pool habitat.

Specific activities:

1. Riparian enhancement - 6.4 km
2. Instream structures - 32.2 km
3 Woody debris - Depended on availability

Land ownership:

100% Private

Water rights:

Not available

Pine Creek

Problem: Pine Creek is in fairly good condition. Grazing by cattle is moderate and does not seem to adversely affect the stream, Only 0.8 km section at SK 2.4 shows signs of floodplain activity. The lower 3.2 km of Pine Creek lacked sufficient instream cover for juvenile steelhead.

Solution: Rip'arian enhancement is recommended for the 0.8 km miles section at SK 2.4 and additional woody debris, pool excavation and log or rock dam structures is recommended for the lower 3.2 km of stream.

Predicted results:

1. Increased instream cover for juvenile salmonids.
2. Decreased erosion and water temperatures below SK 2.4.

Specific activities:

1. Riparian enhancement - 0.8 km
2. Woody debris - As available
3. Log or rock structures - 32 km
4. Pool excavation - 16.1 km

Land ownership:

98% Private

2% Nez Perce Tribe

Rabbit Creek

Problem: Cessation of flow to lower 4.0 km during late summer months: and lack of flow.

Solution: As the watershed of Rabbit Creek is quite small, no enhancement activities are recommended for this stream.

Water rights:

0.04 cfs

Sally Ann Creek

Problem: Sedimentation; and extreme annual stream flow variation.

The section of Sally Ann Creek below the falls (SK 0.8)is in fairly good condition. High spring runoff and excessive sedimentation in the lower end is probably a function of land use practices in headwater areas.

Solution: Riparian enhancement on Sally Ann Creek is recommended above the falls. Check dams or instream deflectors should be located in side tributaries to trap high inputs of sediment.

Predicted results:

1. Decreased peak runoff.
2. Decreased sedimentation.

Specific activities:

1. Riparian enhancement - 3.2 km
2. Side channel defelctors - 16.1 km

Land ownership:

10% State land

90% Private

Water rights:

0.58 cfs

Wall Creek

Problem: Lack of instream cover; sedimentation: moderate annual stream flow variation.

The aquatic habitat found in Wall Creek is generally of high quality. The exceptions are found where the creek flows through pasture land at approximately SK 3.2. Riparian vegetation in general is good.

Solution: Riparian enhancement is recommended in the vicinity of SK 3.2. Sediment collectors should be located in side drainages to prevent the input of sediment from nearby logging operations and grazing activities. Additional instream cover for juvenile salmonids can be provided with the addition of boulder groups, check dams and woody debris in the upper reaches of the stream (cutthroat trout only).

Predicted results:

1. Increased cover for juvenile salmonids.
2. Decreased sedimentation during peak runoff.
3. Decreased' peak runoff.

Specific activities:

1. Sediment collectors located on key tributaries (20).
2. Additional instream cover structures in middle reach(25 structures).

Land. ownership:

7% State

93% Private

Water rights:

0.46 cfs

Three Mile Creek

Problem: Extreme annual stream flow variation: high water temperature: lack of instream cover: sedimentation; and lack of pool habitat.

The Three Mile Creek drainage is generally in poor condition. Sewage effluent from the town of Grangeveille,Idaho flow into this system high in the watershed. Riparian vegetation throughout the upper watershed is degraded due to grazing and agricultural activites.

Solution: Extensive riparian enhancement is recommended in the upper Three Mile Creek watershed. Check dams constructed at strategic locations where sediment input is greatest would reduce sediment load to the lower sections of the stream, which are potentially usable by anadromous salmonids. The lower 9.5 km of Three Mile Creek requires extensive pool construction, which could be maintained with either check dams or boulder groups. In locations where floodplains now exist rechannelization (meanders) is recommended with subsequent riparian enhancement to establish new banks and riparian zones.

Predicted results:

1. Increased pool habitat and instream cover in the lower 9.5 km of stream.
2. Decreased water temperatures and sedimentation.

3. Decreased peak runoff.

Specific activities:

1. Rechannelization 2.4 km
2. Riparian vegetation - 24.1 km
3. Check dams - (sedimentation - 25)
4. Check dams -(Pool construction - 100)

Land ownership:

100% Private

Water rights:

1.24 cfs

Whiskey Creek

Problem: Sedimentation

Except for the upper '4.8 km of Whiskey Creek, where logging and agricultural activities have degraded the riparian zone leading to increase sediment input, the drainage is generally in good condition.

Solution: Riparian enhancement is recommended for the upper 4.8 km of Whiskey Creek. In addition, a dirt road crossing the creek at approximately SK 19.3 should be stabilized to reduce erosion. (resident fish only)

Predicted results:

1. Decreased sediment load to the upper drainage.
2. Decreased water temperature.

Specific activities:

1. Riparian enhancement - 4.8 km
2. Road stabilization - 1 location

Land ownership:

25% State

75% Private

Water rights:

0.49 cfs

Willow Creek

Problem: Sedimentation;lack of instream cover; high temperatures.

Willow Creek is a severely degraded stream due to grazing and agricultural activities. Riparian vegetation is absent throughout most of the watershed. Bank erosion is prevelent along the entire length of the stream proper. Smaller tributaries are generally in better condition.

Solution: Extensive riparian rehabilitation and bank stabilization is recommended for the entire drainage. In addition to short woody vegetation, it is recommended overstory cover also be included due to the exposed nature of the streams location in an open valley.

Predicted results:

1. Decreased bank erosion.
2. Decreased sediment load.
3. Reduced water temperatures.

Specific activities:

1. Riparian enhancement - 11.2 km
2. Bank stabilization - 8 km

Land ownership:

100% Private

CONCLUSIONS

The major objective of this survey was to determine to what extent anadromous salmonids utilize streams which flow all or in part through the Nez Perce Reservation. As this report is the conclusion of two years of inventory, the first which was reported by Kucera et al (1983), this conclusion section will summarize data for both years.

Rainbow-steelhead trout were found in all streams surveyed during 1982 and 1983 with the exception of Cottonwood Creek (SF Tributary). Barriers to migration were found on Cottonwood Creek (SF Tributary), Jim Ford, Three Mile, Lawyers, Whiskey, Sweetwater, Webb and Lapwai Creeks. In the case of the other streams, water flow would be the major limitation to upstream movement of adults.

The five highest densities of overyearling rainbow-steelhead were found in Little Canyon (Middle), Cottonwood (L Middle), Big Canyon (Middle), Big Canyon (L Middle), and Jacks (Middle) Creeks. (Table 72). The five highest densities of subyearling rainbow-steelhead were found in Tom Taha (Lower), Six Mile (Middle), Bedrock (Middle), Pine (#2), and Big Canyon (L Middle) Creeks (Table 73). Chinook salmon, juveniles found occasionally at stream mouths throughoutthe lower Clearwater Basin, were found in great numbers only in Lolo Creek (#4).

In order to plan for the future enhancement of the lower Clearwater River Basin, criteria for prioritization of streams are necessary so that the relative enhancement potential of such streams is rated. The following criteria are very general and are meant only to identify the four streams with the most enhancement potential from all streams surveyed.

The most critical parameter affecting fish production is the amount of waterflow within a stream. The amount of flow dictates the extent of enhancement of the habitat. The second most critical parameter is the quality of the water, including temperature, nutrients, and pollutants. The third parameter, in order of importance to fish production, is the rate of sediment input into the stream The fourth factor, and by far the easiest to enhance, is the physical habitat (depth, width, velocity, cover, etc.). These parameters are also in order of their complexity and cost in relation to attempts to alter their present conditon.

Following this line of reasoning, two streams were identified from the group surveyed during 1982 and 1983 as having the best potential for enhancement of anadromous fish production.

1. Lolo Creek System
2. Big Canyon Creek System

These streams had the largest watersheds and the highest annual flows with good quality water in the lower basin. Both streams exhibited problems with sedimentation and habitat availability to varying extents.

Two additional criteria are necessary to finalize the prioritization process. These are not physical but policy criteria. The first consideration is the importance of the species to be enhanced. The second consideration is the excediency of an enhancement project (i.e., a project would be easier if done on land controlled by the initiator of the project). Federa1, State, or Tribally controlled land would be easier to access than privately owned land.

The top two streams which have most potential for enhancement within the lower basin are:

1. Lolo Creek System

This stream has the highest flow' of good quality water of those streams surveyed. This stream can support both rainbow-steelhead trout, spring chinook, and possibly fall chinook salmon. Ninety percent of the critical land associated with this stream is either federal or state controlled.

2. Big Canyon Creek System

This stream has one of the two highest flows of good quality water. It can support rainbow-steelhead trout in its lower 19.3 kilometers. Only about 5% of this critical land is controlled by the federal government. The inaccessability and its location entirely within the Nez Perce Reservation make enhancement of this stream feasible,

Most of the streams inventoried during 1982 and 1983 were found to have habitats in marginal condition,though a wide range of habitat conditions were found from good to bad. The majority of these streams were at a point where further degredation could severely limit salmonid production. As the streams inventoried were generally small with privately owned watersheds, enhancement activities may be logistically complicated (easements, land use contracts, right of lays). Habitat protection to maintain the stream systems in their present state of marginal salmonid production may be the priority approach.

Orofino Creek, Potlatch River and Clear Creek also flow within the reservation, and are large systems similar to Lolo and Big Canyon Creeks. Inventory data is lacking on these streams and it is reccommeded that inventory activities continue on these streams.

The Habitat Quality Index (HQI)was originally intended to describe the relationships between salmonid biomass and habitat quality. These relationships have yet to be modelled accurately. This model would have potentially described the carrying capacity of the streams surveyed which would have identified to what extent the streams were seeded by returning adults. In addition, the optimum production within the streams (following enhancement activities) could have been predicted. These data **are** critical to the enhancement planning and prioritization process.

Table 72. A ranking of overyearling rainbow-steelhead population found in the lower Clearwater River Basin, Idaho, 1982, 1983.

Stream	Station	Standing Crop kg/ha	Density fish/m2
Little Canyon	Middle	89.1	0.13
Cottonwood	L Middle	87.6	0.22
Big Canyon	Middle	78.6	0.18
Big Canyon	L Middle	42.8	0.13
Jacks	Middle	41.7	0.19
Whiskey	1	39.8	0.02
Sally Ann	1	38.6	0.39
Pine	2	37.8	0.25
Bedrock	Middle	35.6	0.16
Bedrock	2	35.6	0.60
Yakus	1	31.4	0.18
Big	1	26.7	0.08
Wall	1	24.3	0.18
Lapwai	Middle	24.2	0.04
Butcher	2	23.1	0.06
Lolo	5	22.2	0.13
Jim Ford	2	21.8	0.07
Big Canyon	Lower	20.4	0.04
Mission	U Middle	18.7	0.03
Pine	1	17.3	0.10

Table 73. A ranking of subyearling rainbow-steelhead population found in the lower Clearwater River Basin, Idaho, 1982, 1983.

Stream	Station	Standing Crop kg/ha	Density fish/m2
Tom Taha	Lower	98.2	
Sixmile	Middle	55.1	
Bedrock	Middle	23.1	
Pine	2	18.4	
Big Canyon	Middle	17.5	
Whiskey	1	14.9	
Sally Ann	1	14.7	
Little Canyon	Middle	13.2	
Jim Ford	2	9.6	
Cottonwood	L Middle	7.5	
Lapwai	Middle	6.9	
Yakus	1	6.7	
Wall	1	5.2	
Clear	Middle	4.7	
Maggie	2	3.3	
Cottonwood	Middle	3.1	0.2
Lolo	5	3.0	
Sweetwater	Middle	2.2	0.1

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RED RIVER HABITAT IMPROVEMENT

ANNUAL REPORT, 1983

BY

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Funded by

Bonneville Power Administration
Division of Fish and Wildlife
Agreement No. DE-AI79-83BP11985
Project No. 83-501
Project Officer: Larry Everson

ANNUAL REPORT

TITLE: Red River Habitat Improvement and Rearing Facility, South Fork Clearwater River, Idaho.

AGREEMENT #: DE-AI79-83BP11985
(BPA Project 83-501)

PROJECT PERIOD: June 15, 1983 - December 31, 1983

ABSTRACT: Commenced work on first year of a seven year project. Activities included installation of instream structures, bank protection Through riparian fencing, bank stabilization through planting of both conifers and deciduous trees and shrubs, and seeding and fertilizing of disturbed sites.

INTRODUCTION In 1927 a dam was constructed on the South Fork of the Clearwater River, at Harpster, which totally eliminated anadromous fish runs into this important spawning and rearing habitat. In 1935 a fish ladder was constructed at the dam but was reportedly only minimally successful. In 1962 the dam was completely removed. By this time however the azadromous runs had been eliminated from the drainage.

Idaho Fish and Game began a program of re-introduction of anadromous salmonids in 1962. A hatching channel was constructed at the Red River Ranger Staticn and stocked annually with eyed eggs. Species stocked has varied and included coho salmon, chinook salmon and steelhead. Most of the recent use (1978-1983) has been with steelhead. In 1977 Idaho Fish and Game constructed a rearing pond at Red River which is used to rear 200,000-300,000 chinook salmon annually. The pond is stocked with fry in the spring. After rearing in the pond over the summer, a portion are marked and all are released into Red River at the pond site.

The U.S.F.S. began a program of active habitat improvement in the Red River system in 1980 which continued in 1981 and 1982. Since the B.P.A. project proposal has been approved, the District has directed its emphasis to the South Fork of Red River which will complement the B.P.A. work being carried out in Red River itself. The 1984 U.S.F.S. contribution to the rehabilitation of Red River (South Fork) will be $10,000.

DESCRIPTIOIN OF PROJECT AREA: The project is on the Red River Ranger District of the Nezperce National Forest at T. 28 N., R. 9 E. and R. 10 E. (Figure 1).

The project area itself consists of approximately 19 miles of stream with 50% on U.S.F.S. land and 50% on private land. Stream reaches involved include both meandering meadow reaches and timbered valley bottoms. Fish habitat problems are the result of overgrazing and previous dredge mining for gold.

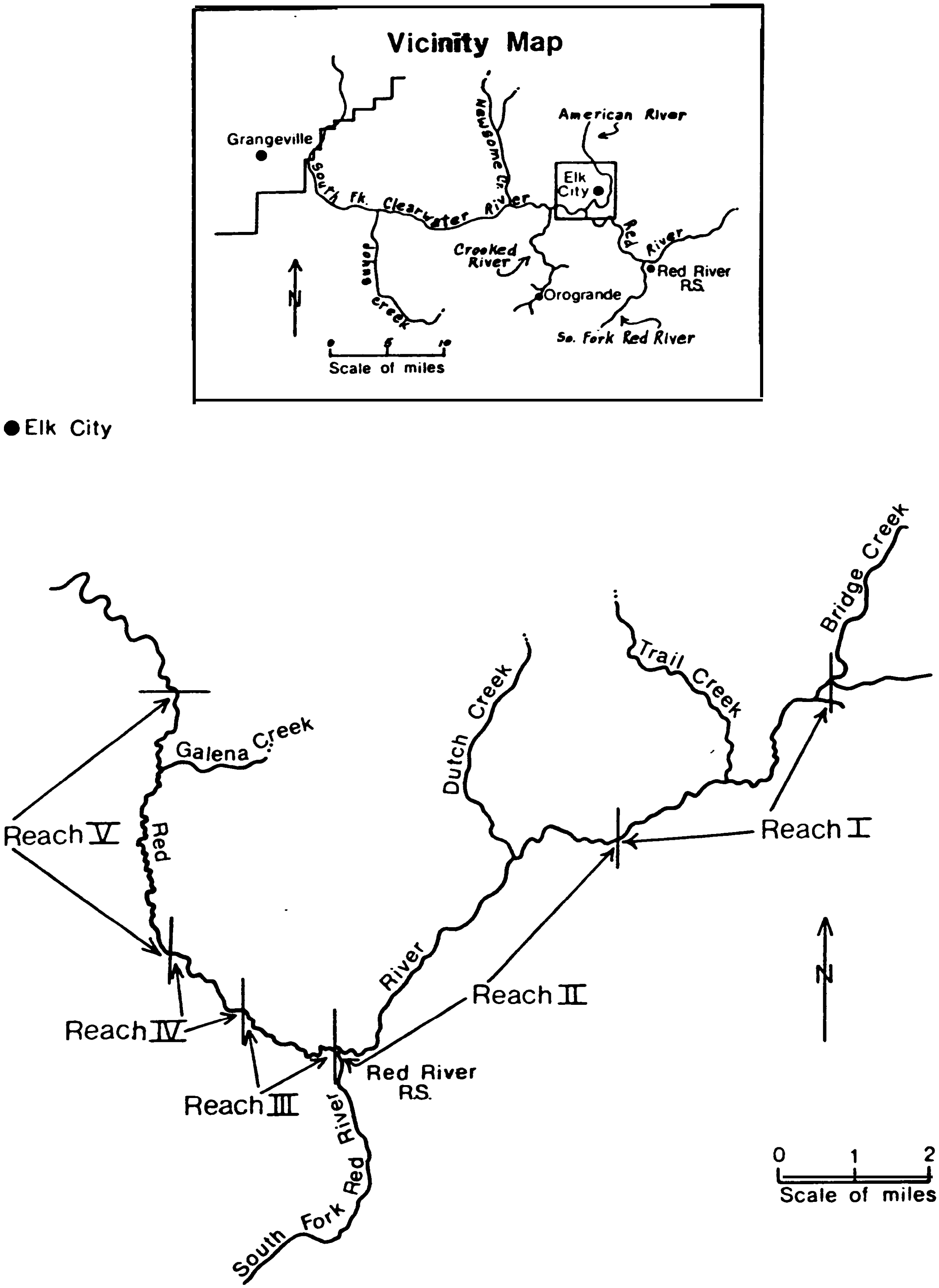
APPROACH AND METHODS: Because of the scope of the project and multiple land ownership pattern, it was necessary to develop a systematic approach forevaluaction, design and execution of the project. The first step was to separate the stream into reaches with similar characteristics. Next each reach was separated into individual project segments based on ownership, within five stream reaches. Table 1 lists the project segments, ownership and reach length.

After stream reaches were identified each reach was evaluated and fish habitat problems listed along with potential habitat improvement projects. This evaluation will undergo constant review and revision until the final project design is selected.

Methods used in 1983 were standard fish habitat improvement projects including deflectors, bank overhangs, bank stabilization structures, riparian fencing, boulder placement and riparian vegetation planting. In addition, some different structures were used which will be evaluated during the next field season. These include whole trees dropped into the stream and cabled into place. These were placed at a 30° angle downstream (to duplicate naturally occurring stable conditions) and use of rock filled log cribs instread of boulders. One structure was designed as a sediment trap to settle out sediment which can then be stabilized through re-vegetation.

FIGURE 1

Red River Fish Habitat Improvement Project



RESULTS AND DISCUSSION: Project area IV was selected for most activity this year. The problems associated with this reach are due to past dredge mining for gold. The reach lacks instream cover, bank cover and holding water for rearing juveniles and adults. Water depths appear to be adequate through most of the reach. Table 2 lists the number and type of activities carried out this year.

Field activities this year included:

1) 50 boulders placed in stream (photos 1 & 2)

2) 4 deflector/cover structures (photos 3, 4 & 5)

3) 9 trees placed in stream (photos 3 & 4)

4) 222' of bank stabilized with logs (most provides overhead cover) (photo 6)

5) 21,120' of riparian planting with conifers

6) 3700' of riparian planting with deciduous trees and shrubs

7) 1100' of jack leg fence constructed

8) 2.1 acres seeded and fertilized

TABLE 1

B.P.A./F.S. RED RIVER FISH HABITAT IMPROVEMENT PROJECT SEGMENTS

Project Segment	Stream Length	Ownership	Improvement Opportunity
I-A	3600'	U.S.F.S.	Low
I-B	5100'	Private	Low
I-C	6000'	Private	High
I-D	3600'	Private	Low-Medium
I-E	2100'	U.S.F.S.	Low-Medium
I-F	9300'	Private	Medium
Subtotal:	5.6 Miles		
II	5.5 Miles	U.S.F.S.	High
III-A	2000'	U.S.F.S.	Medium
III-B	4300'	Private	Low-Medium
III-C	3300'	Private	High
Subtotal:	1.8 Miles		
IV	2.0 Miles	U.S.F.S.	High
V-A	2600'	Private	High
V-B	7200'	Private	High
V-C	4000'	Private	High
V-D	5400'	Private	High
V-E	1000'	U.S.F.S.	High
Subtotal:	3.8 Miles		

TOTAL: 18.7 Miles

TABLE 2

Red River Accomplishments 1983

A. PHYSICAL ACCOMPLISHMENTS	Area IV	Other Sites
1. Sediment trap/cover	1	
2. Controlled debris clusters (1-3 trees)	7	2
3. Deflectors/cover structures	3	
4. Bank stabilization (log)	222 feet	
5. Conifer planting (donated by F.S.) Shade and soil stabilization (2 miles both sides)	21,120 feet (4000 trees F.S. donated)	
6. Deciduous planting (purchased)	3200 feet (750 plants)	500 feet (130 plants)
7. Jack leg fence		1100 feet
8. Structure maintenance		5 K-dams
9. Seeding and fertilizing	2 acres	0.1 acre
10. Moved 440 boulders to project area IV		
11. Placed 50 boulders	50	

B. PLANNING ACCOMPLISHMENTS

1. Low level aerial photo flight for Red River.
2. Contacted, by mail, all landowners with property containing Red River.
3. Personal contact with six major landowners and three minor landowners to discuss potential projects on their property.
4. Developed overall project time schedule.
5. Developed project programmatic plan (identified problems and solutions by stream reach)
6. Completed specific plan for project segment IV.
7. Carried out fish habitat surveys at 13 sites covering all five stream reaches.
8. Began preliminary project segment inspections to evaluate potential project activities, access points, etc.

BOULDER PLACEMENT - RED RIVER

Photo 1 - Typical reach before boulders placed

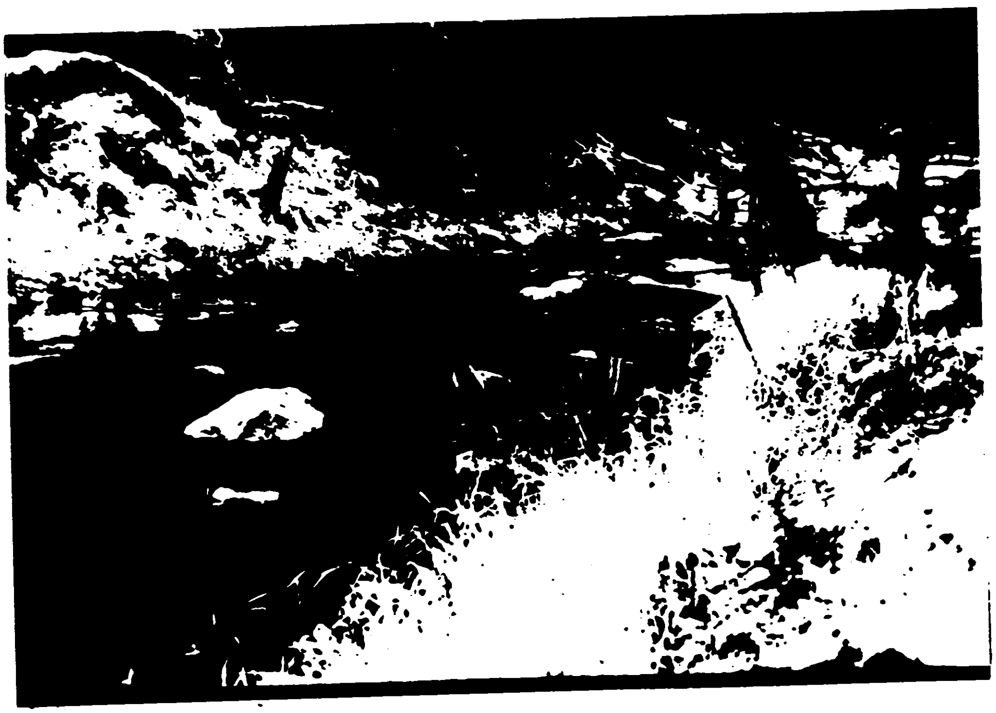


Photo 2 - After boulders placed

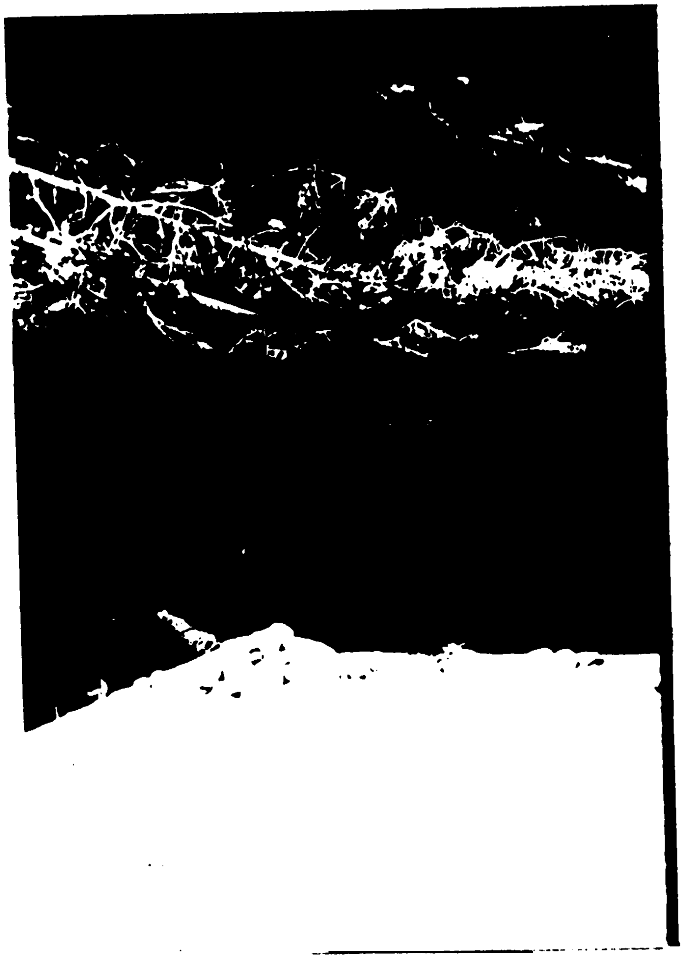


Photo 3 - Bank deflector/cover cabled tree cover

Photo 4 - Bank deflector/cover cabled tree cover

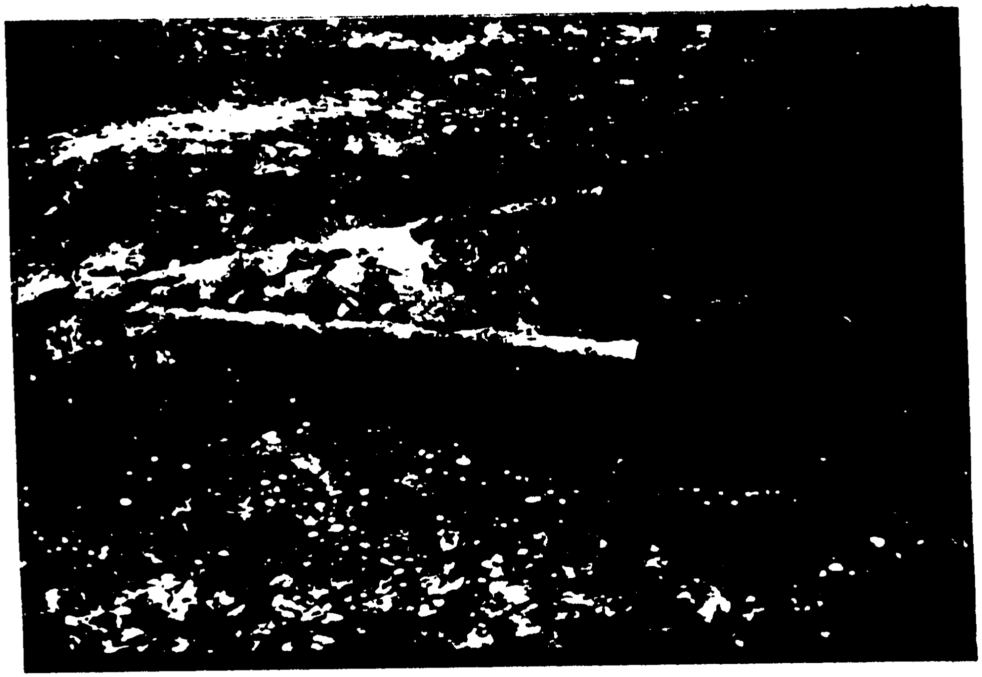


Photo 5 - Midstream deflector/cover

BANK STABILIZATION - RED RIVER

Photo 6 - Eank stabilization with logs.

Logs placed at toe of slope and edge cf eroding bank and backfilled. Placed to provide overhead cover at all flows.

Due to the fact that the interagency agreement was not signed until the middle of June and the project biologist was not hired until the first of July, the accomplishments were not as great as hoped for this year. However, due to the multi-year scheduling of this project it is anticipated that the scheduled 1990 completion date will be met.

Planning activities included scheduling a low level aerial photography flight, contacting all landowners by mail and making personal contacts with as many as possible and developing a systematic approach to accomplish the project. During discussion with Forest personnel, it was felt that the environmental assessment used was not definitive enough for Forest Service needs and a project environmental assessment will be completed prior to the 1984 field season.

A site specific monitoring program was initiated utilizing a fishery crew from the USFS Intermountain Research Station. Dr. Bill Platts directed the crew and will be analyzing the data. As of 1984 Idaho Fish and Game will be responsible for monitoring projects from the oversight position funding. The monitoring plan consists for setting up 2-1200' transects each with 600' treatment and 600' control. This year sampling was the "pre-treatment" Phase for one set of transects. The plan was to monitor both control and treatment segments after treatment to evaluate "benefits" through evaluation of increased production both numbers and biomass. It is hoped the Idaho Fish and Game will continue this monitoring plan.

Problems encountered this year included confrontation with the holder of an unpatented mining claim; and the fact that just prior to approval of this project a large minerals company obtained easements and/or leases on approximately 3 miles of private meadow which was anticipated to be a major activity area for the project, this precluded any work during 1983. The mining company has since finished test drilling and evaluating samples; and has terminated all its interests in the area. We anticipate beginning the planning phase for this area the summer of 1984.

We are currently ready to work on five Forest Service segments; and private land segment in 1984 assuming the necessary easement can be obtained. The easement will be done by Idaho Fish and Game under their BPA funding.

SUMMARY AND CONCLUSIONS:

1. This project has high potential to increase production of anadromous salmonids. Problems encountered this year were due to lack of lead time and incomplete planning. This situation will not occur in future years.

2. Limiting factors include lack of:
   - A. Instream cover
   - B. Undercut banks
   - C. Adequate pools
   - D. Bank vegetation and bank erosion.

Habitat improvements will be designed to resolve these problems.

3. Efficiency of field work can be improved by using smaller field crew

and more heavy equipment. This will be done in 1984.

4. Structures installed this year and structures installed previously by the Forest Service will be monitored through high water to determine suitability for use in this stream system.

SUMMARY OF EXPENDITURES:

1983 4/15 - 9/30/83 Total Budget $82,504

Salary	43,043
Equipment & Materials	9,457
Travel & Transportation	5,815
Contract equipment use	11,423
Overhead	4,234
	$73,972

Sensitive items purchased and tagged with BPA property numbers.
Texas Instruments TI-55-11 Calculator
Clympus OM-1 Camera w/l.4 lens

1983 FS Donated Funds (&/or materials)

FS specialist time------	lo man days
Conifer trees	4800 trees
Value of green posts/poles & nails	
#9 smooth wire	200 ft.
¼" cable	75 ft.
fertilizer	150 lbs.

*End of year billing not included.

CROOKED RIVER PASSAGE IMPROVEMENT

ANNUAL REPORT, 1983

BY

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Funded by

Bonneville Power Administration
Division of Fish and Wildlife
Agreement No. DE-AI79-83BP11981
Project No. 83-502
Project Officer: Larry Everson

ANNUAL REPORT

TITLE: Crooked River Passage Improvement

AGREEMENT #: DE-AI79-83BP11981
(BPA Project 83-502)

PROJECT PERIOD: June 15, 1983 - January 31, 1984

ABSTRACT: Proposed project to replace a culvert with a pipe-arch was modified (with BPA approval) to install a bridge instead. Design changes and administrative problems with right of way necessitated one year delay in construction. Site surveys are completed, and bridge design is underway.

INTRODUCTION

Crooked River is a tributary to the South Fork of the Clearwater River System. Crooked River is 17 miles long and enters the South Fork of the Clearwater River at river mile 58.4. Murphy and Metsker (1962) surveyed the Crooked River and found it contained 8,707 and 5,026 square yards of suitable spawning gravel for steelhead and salmon, respectively.

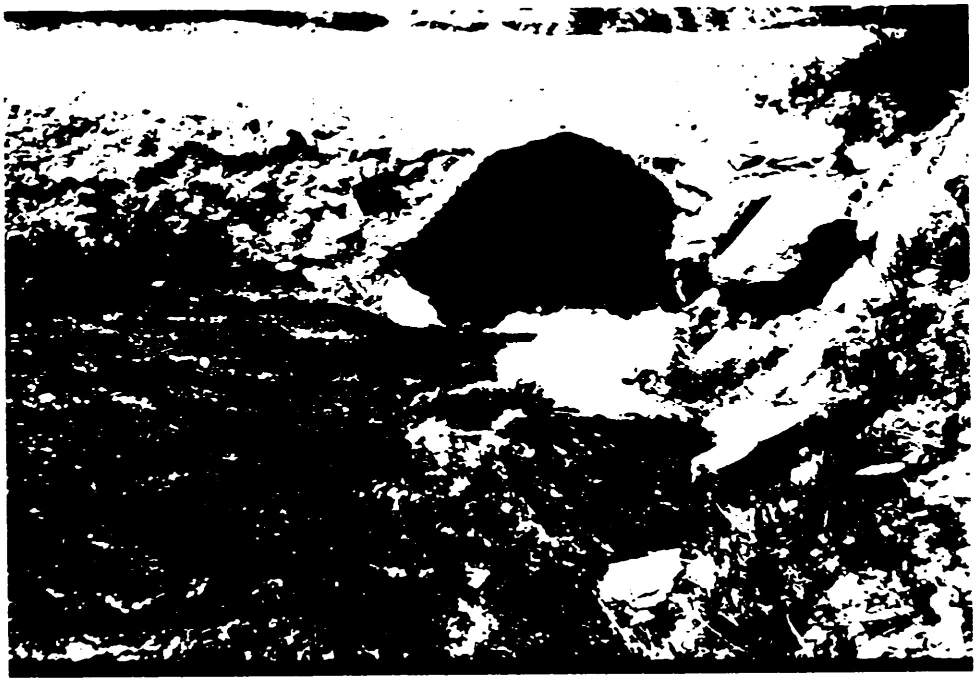
Current steelhead smolt production potential is reduced by approximately 39 percent due to a long existing culvert passage block (See attached photos). The culvert was improperly installed in the early 70's A survey conducted by FWS during FY 1982 indicated that 4,533 square yards of useable steelhead and chinook spawning habitat occurred above the culvert block. Replacement of this culvert offered the potential to increase steelhead production potential by 18,690 smolts annually.

PROJECT DESCRIPTION

Project planning began with a Forest Service stream survey of Crooked River during FY 1978. During FY 1981 a more detailed list of habitat conditions was assembled, with a cost work up and design for replacing the existing culvert. This work was funded by the Forest Service. The initial project plan involved the removal of the existing culvert and installation of a pipe-arch. Considering road width and instream flows, a 14' 1" x 8' 9" pioe-arch was determined to be sufficient to provide fish passage and also carry the required 20- and 50-year flood events.

During a field review of the project on July 19, 1983, it was brought out that a much better solution to the problem would be installation of a bridge rather than a pipe-arch. The project leader pursued this proposal with BPA - Fish and Wildlife Division and was told to proceed with the design change. Using $2,500 Forest Service contributed funds, the bridge site was surveyed, test drilled at footing sites, and is being designed.

CROOKED RIVER CULVERT
FISH PASSAGE BARRIER



UPSTREAM END OF CULVERT

DOWNSTREAM END OF CULVERT

RESULTS AND CONCLUSIONS

The U.S. Forest Service received approval to change the design for the crossing from a pipe-arch to a bridge. Forest Service Engineering section has surveyed in the bridge location and designed a treated timber bridge for this site.

Because of administrative problems involved (U.S. Forest Service doing work on County right-of-way on private land - patented mining claim), the actual installation of the bridge was delayed one year (with BPA approval). All problems have now been resolved and the bridge will be constructed in 1984.

SUMMARY OF EXPENDITURES (Total Budget: $24,985)

FY 1983		$ 0
FY 1984:	Salaries	1362
	Travel and Transportation	127
	Nonexpendable Equipment and Material (greater than $1000/item)	0
	Expandable Equipment and Material	0
	Sensitive Items	0
	Operations and Maintenance	0
	Overhead	0

Total as of 11/30/83:$1489

..S. Contributed Funds

Prior to 1983	$3,000
1983	2,500

ALTURAS LAKE CREEK FLOW AUGMENTATION

ANNUAL REPORT, 1983

BY

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Sawtooth National Forest
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Funded by

Bonneville Power Administration
Division of Fish and Wildlife
Agreement No. DE-AI79-83BP11994
Project No. 83-415
Project Officer: Dale Johnson

ANNUAL REPORT: Project Number 83-415, Alturas Lake Habitat Improvement

Abstract

The first year of a two year study to determine the feasibility of augmenting stream flows in Alturas Lake Creek, during the summer and fall when natural flows are insufficient to meet irrigation demands and fishery needs, has been completed. All aspects of the feasibilitv study, including legal, biological, engineering, hydrologic and economic aspects, have been initiated. To date, no aspect of the feasibility study has eliminated either of two identified alternatives: dam construction to provide storage capacity for fishery releases, and water right acquisition. The methods employed in the feasibility study and results of the investigations to date are detailed.

Introduction

An outstanding opportunity exists to enhance natural production of spring chinook salmon and reestablish sockeye salmon production in the Alturas Lake basin of the upper Salmon River. Diversion of flow from Alturas Lake Creek (ALC) for irrigation purposes annuallv dewaters the stream, reducing chinook salmon spawning and rearing habitat availability and eliminating sockeye salmon production potential. Two approaches have been suggested to resolve this conflict between irrigation demands and fishery needs. The first is construction of an outlet control structure on Alturas Lake to store spring runoff for release into ALC in late summer and early fall to accomodate upstream migrating and spawning chinook and sockeye salmon. The second approach is to acquire all or part of the water rights held on ALC for instream use bv the fish. The first phase of this project, initiated April 1, 1383, is designed to evaluate the feasibility of implementing these alternatives, including development of cost and benefit information.

Study Area

Alturas Lake Creek drains 66 square miles of forested slopes of the Sawtooth and Smoky mountain ranges. It is a major tributary to the Salmon River, entering at Township 7N, Range 14E, Section 20, approximately 17 miles upstream from Stanley, Idaho. Flows from this drainaqe primaily originate as snow melt, beginning to increase in April from base flow conditions to peak flows in June and then quickly recede to near base flow conditions in August. These flows feed two morainal lakes, Alturas (838 acres) and Perkins (50 acres).

The drainage contains some of the best spring chinook and sockeye salmon habitat in the Salmon River basin. Unfortunately most of this habitat, some 8 miles *of* stream and nearly 900 acres of lakes, lies above the diversion dam and is inaccessible to these anadromous species. The water rights held on ALC total 37.84 cubic feet per second (cfs), date back to the 1930's, and are diverted from one point (ALC-1). Ditch capacity at ALC-1 is about 50 cfs, more than the average natural flows instream during the upstream migration and spawning periods of chinook and sockeye salmon.

Methods

Evaluation of the feasibility of augmenting stream flow in ALC has been divided into eight study segments, identified as "information needs." Applicable work tasks were then identified to meet the information need. Information needs, and methods used to resolve the needs are detailed below.

Lega 1 Issues. Legal issues pertinent to flow augmentation, including water right acquisition, were identified and submitted for legal opinion to the U.S. Department of Agriculture, Office of the General Council and to the Idaho Department of Water Resources. Valuation of water rights will be determined by certified appraisal.

Instream Flow Needs. Instream flow needed to provide upstream passage, spawning, egg incubation and rearing are determined using an Instream Flow Incremental Methodology. A memorandum of understanding has been developed with the U.S. Fish and Wildlife Service to provide field assistance in data collection and computer analysis of that data.

Stream Habitat Inventory. The amount and quality of chinook salmon spawning and rearing habitat has been assessed using standard Region 4 Forest Service inventory methodologies, in which physical habitat parameters are summarized by 100 meter intervals. This production capability information will be used to refine expected benefit estimates.

Lake Habitat Inventory. A contract has been awarded to the Idaho Department of Fish and Game (IDF & G) to develop a model for estimating sockeye salmon production in the Alturas Lake system. IDF & G is also stocking Alturas Lake with juvenile sockeye, in anticipation that the flow conflicts will be resolved.

Preliminary Dam Design/Cost Estimates. U.S. Forest Service engineering and geotechnical staff will develop, from site surveys, preliminary dam designs and cost estimates, for the outlet control structure to provide storage capacity for fishery flows and modification, or reconstruction of the diversion dam necessary to: 1) deliver no more water than the decreed water right to the irrigator's ditch during the period of upstream migration, spawning and incubation, 2) concentrate flows into a single channel rather than dividing it between two channels, 3) provide for upstream passage at the diversion structure itself, and 4) screen downstream migrating juveniles from the irrigation system.

Impacts Associated With Impoundment. If a dam is constructed on the outlet of Alturas Lake to store water and regulate outflow from the lake there would be certain environmental costs. The effects of elevating the lake level on the lake shore and its associated values (e.g. beaches, developed recreation sites, timber, soils, visuals, cultural resources, etc.) will be assessed by an Interdisciplinary Team assembled by the Forest Service.

Hydrologic Relationships. U.S. Forest Service hydrological staff, from the Intermountain Regional Office, have provided assistance in study design, data collection and analysis to determine the hydrologic relationships between the primary inlet to Alturas Lake, the outlet stream and delivery to the point of diversion. Permanent gaging stations have been established at three locations in the ALC system. Other aspects of the hydrologic cycle (e.g. quantity of water produced in the watershed, amount of evaporation from Alturas Lake) have also been defined using standard methodologies.

Maintenance Responsibility for structural Improvements. Maintenance responsibility for any structural improvements built as a result of this project will be negotiated among the Forest Service, Idaho Department of Fish and Game, the National Marine fishery Service, and Bonneville Power Administration.

Results/Discussion

Significant progress for the first year of the feasibility study phase of the project is summarized by information need below.

Legal Issues. Legal issues pertinent to instream uses of water, water developments, and water right acquisition have been addressed. No legal issues were surfaced which would preclude implementation of either of the identified alternatives. A contract has also been developed, and will be awarded in the near future, to have a certified appraiser familiar with water right evaluation, appraise the value of Alturas Lake Creek water rights.

Instream Flow Needs. Instream Flow Incremental Methodology techniques have been employed to define stream flows necessary to meet various levels of upstream migration, spawning, incubation and rearing criteria. Results of these studies suggest that either of the identified alternatives would provide sufficient flows instream to effectively mitigate the impacts of ALC-1 on anadromous fish production capability.

Stream Habitat Inventory.

Habitat inventory data suggest that in the Alturas Lake system rearing habitat is the factor limiting chinook salmon production. More than 80 per cent of the suitable rearing habitat lies above the diversion, and is therefore, currently inaccessable to chinook. There is adequate spawning habitat above the diversion to seed this rearing habitat. The increase in production capability associated with accessing this habitat is estimated at 120,000 to 160,000 chinook smolt/year.

Lake Habitat Inventory. Completion of a model to estimate the potential production of sockeye salmon in the Alturas Lake drainage is anticipated by July of this year. Preliminary estimates suggest the increase in production capability associated with accessing this habitat to be at least 509,000 sockeye smolt/year

Preliminary Dam Design/Cost Estimates. Site surveys at the outlet of Alturas Lake and at ALC-1 have been completed. Engineering staff are currently developing a report which will present: 1) a discussion of general dam requirements, 2) alternative dam types and associated cost estimates, and 3) conclusion and recommendations for the dam site at the outlet and for the diversion structure.

Impacts Associated with Impoundment. Primary concerns with the storage alternative involve the impacts which the project could have on popular recreational facilities adjacent to Alturas Lake. To better define the extent of potential impacts, elevational surveys were completed at all recreational facilities that may be affected. Those surveys identified two possible areas of impact; a boat launching facility in the Smoky Bear Campground and the Inlet Beach picnic area. Topographic maps are being developed for the inlet area to help in the assessment of the magnitude, and mitigatability, of the impacts associated with impoundment.

Hydrologic Relationships. Staff gage/stage relationships have been developed for the three permanent gaging stations. Those relationships will continue to be refined as more information is collected at each site. Water production and evaporation estimates indicate that the flows necessary to provide the desired storage capacity are available every year (i.e. water storage requirements, represent only a small portion of spring runoff flows).

Maintenance Responsibility for Structural Improvements. The Forest Service (FS) has met with representatives of the Idaho Department of Fish and Game (IDF & G) and the National Marine Fisheries Service (NMFS) to discuss maintenance responsibility for any structural improvements (e.g. dam, fish screen, fishway) associated with resolving the instream flow conflicts on ALC. NMFS felt they would probably be able to fund maintenance of an ALC-1 fishscreen. IDF & G expressed the possibility that they may be able to accept maintenance responsibility for a dam, as part of the function of the Sawtooth Hatchery being built near Stanley. The F.S. expressed the possibility that they may be abl to assist in light maintenance and operation of the dam by using campground patrol personnel that are at the site daily. Maintenance responsiblity will be firmed up at the time of alternative selection.

Summary and Conclusions

The feasibility of augmenting stream flows in Alturas Lake Creek to enhance natural production of chinook salmon and re-establish sockeye salmon in Alturas Lake is being evaluated in a two year study. The report presents the results of the first year of that study. Legal, biological, engineering, hydrologic, and economic feasibility analyses have been initiated to determine the costs and expected benefits of two alternatives to resolve a conflict between irrigation diversion and fishery needs. The two alternatives being considered are: 1) construction of an outlet control structure on Alturas Lake to store spring runoff for release into the stream necessary to accomodate upstream migrating and spawning chinook and sockeye salmon and 2) to acquire all or part of the water rights held on Alturas Lake Creek for instream use by the fish. Results of the feasibility study to date have not eliminated either of these alternatives. It is likely that the value of the results of the feasibility work will be to suggest which alternative is most attractive from a cost/benefit view, or environmental soundness perspective.

POLE CREEK IRRIGATION DIVERSION SCREENING

FINAL REPORT, 1983

By

Harvey Forsgren, Fishery Biologist
Sawtooth National Forest
Twin Falls, Idaho

Funded by

Bonneville Power Administration
Division of Fish and Wildlife
Agreement No. DE-AI79-83BP11991
Project No. 83-416
Project Officer: Dale Johnson

FINAL REPORT: Project No. 83-416 Pole Creek Irrigation Diversion Screening

ABSTRACT - Chinook salmon and steelhead trout production in Pole Creek, a tributary to the Salmon River near Sawtooth City, Idaho, has for many years been limited by irrigation diversion. The abstracted water rights (65.6 cfs), diverted from seven points along the stream, exceeded the total flow instream throughout most of the irrigation season, leaving the mouth of Pole Creek dewatered. In 1982 the mode of irrigation on those lands adjacent to Pole Creek was changed from "flood" to "overhead sprinkler". The new irrigation system requires only 12-18 cfs drawn from one point, and leaves enough water instream to reestablish chinook and steelhead runs to Pole Creek. As an essential component of efforts to reestablish anadromous stocks in Pole Creek, a fish screen on the diversion has been constructed to protect downstream migrating smolts.

INTRODUCTION

Pole Creek, a tributary to the Salmon River near Sawtooth City, Idaho, is considered to have among the highest quality spawning and rearing habitat in the Salmon River basin for chinook salmon and steelhead trout. The stream has tremendous potential to produce these species. For many years that production capability has been eliminated by irrigation diversion practices. The abstracted water rights (65.6 cfs) diverted from seven points along the stream until 1982, exceeded the total flow instream throughout most of the irrigation season, left the mouth of Pole Creek dewatered, and prevented chinook salmon access to the stream. Smolt produced by steelhead spawning in the stream prior to the irrigation season, were in large diverted from the stream, during the irrigation period to the fields where they parished.

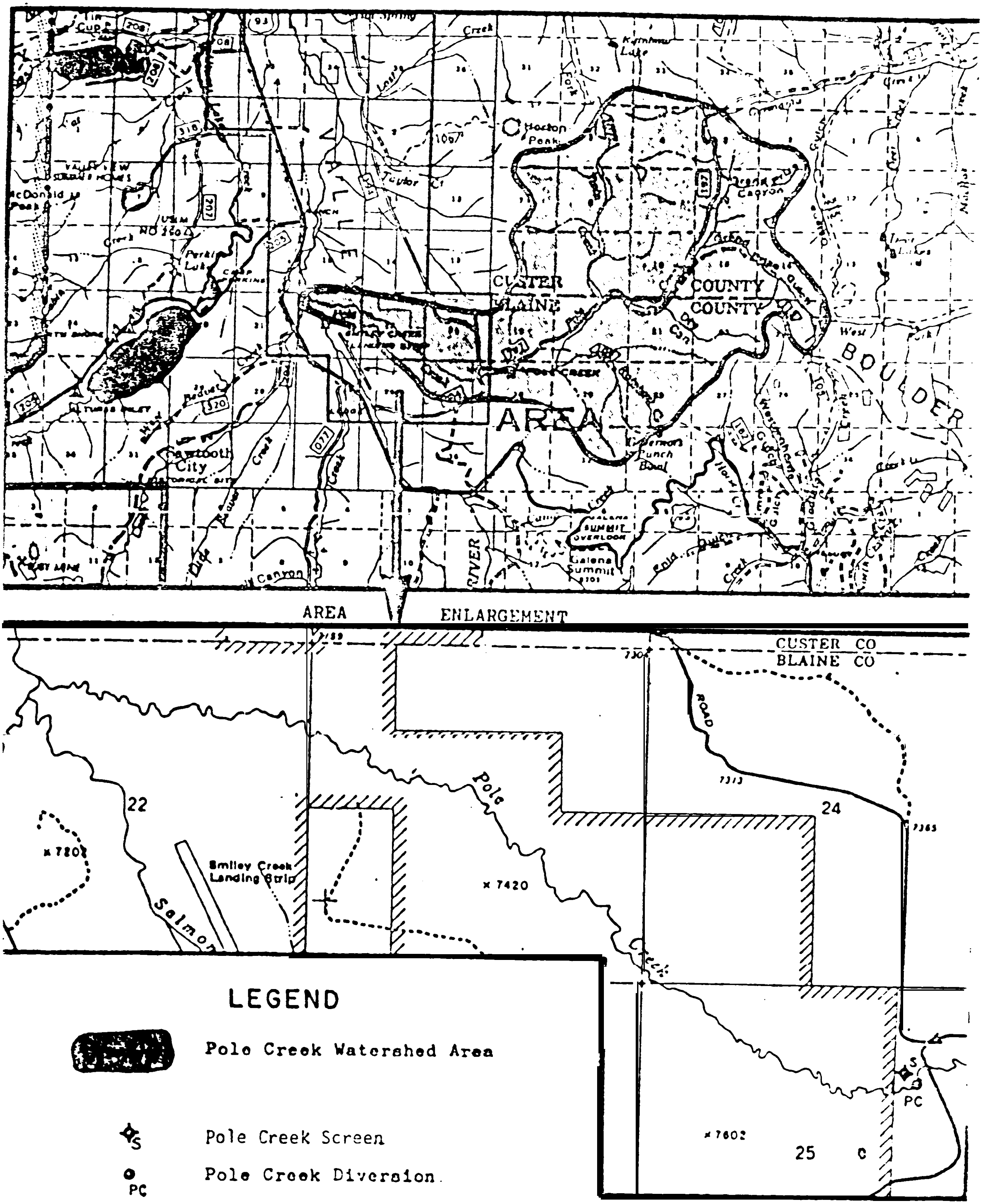
In 1982 the mode of irrigation on the lands adjacent to Pole Creek was changed from "flood" to "overhead sprinkler". The new irrigation system requires only 12-18 cfs drawn from one point, and leaves enough water instream to provide for up and downstream passage, spawning and rearing of chinook salmon and steelhead trout. As an essential component of cooperative efforts with the State of Idaho to reestablish anadromous stocks in Pole Creek, a fish screen on the diversion was needed to protect downstream migrating smolts. Construction of that screen is the subject of this report.

STUDY AREA DESCRIPTION

The area of this screen construction project lies in the upper drainage basin of the Salmon River in Baline County, central Idaho (Figure 1). Pole Creek originates in the Boulder-White Cloud mountains. The virgin streanflow in Pole Creek is the result of snowmelt for peak flows, while streamflow the rest of the year is consistent because of the moderating influence of the headwater spring sources Discharge in Pole Creek remains relative constant from August through April. Flows rise rapidly in May, peak in June and more rapidly descend in July.

Among fishery biologists familiar with the streams of the upper Salmon River basin, Pole Creek is considered to he among the streams providing the highest quality of fisher? habitat for chinook salmon and steelhead trout. Aquatic habitat surveys of Pole Creek by Idaho Department of FIsh and Game (IDFG) and U.S. Forest Service biologists suggest the 5 miles of stream above the irrigatioin diversion have the potential of supporting 937 chinook spawners and 563 steelhead spawners.

Figure 1.
Pole Creek Watershed



METHODS AND MATERIALS

This screening project is related to Measure 704 (d)(1), Table 5 (item A), in the Northwest Power Planning Council's Fish and Wildlife Program (November 1982). With the concurrence and support of IDF&G the Sawtooth National Forest entered into an agreement with the Bonneville Power Administraton on April 1, 1983 to complete the screening of the Pole Creek diversion. Project costs were not to exceed $29,725.

The overall project objective is to increase the production potential of chinook salmon and steelhead trout by screening downstream migrants from the irrigation diversion where they parish. To accomplish this objective, the Forest Service contracted with IDF&G to design, construct and install a suitable screen(s) for the site, at a cost not to exceed $28,000.

RESULTS

Early in the 1983 summer season IDF&G engineering personnel completed surveys necessary for design of the screen and staked the construction site. Arrangements were made with the water right holder whereby the Department agreed to delay construction activities until the end of the irrigation season so as to not interfer with his water supply and to simplify construction operations.

Remoteness of the site and nature of the diversion ditch suggested installation of a single rotary drum screen powered by a paddle wheel similar to the screen pictured in Figure 2. Excavation, and concrete work was initiated in the middle of September following cessation of irrigation activities (Figures 3 and 4.) All concrete work and back filling was completed by September 30, 1983 (Figure 5 and 6). The screen and paddle wheel to power the screen were fabricated at the IDF&G workshop at Salmon, Idaho (Figures 7 and 8). The screen and paddle wheel will be stored in Salmon over winter and bolted in place this coming spring prior to the initiation of the irrigation season.

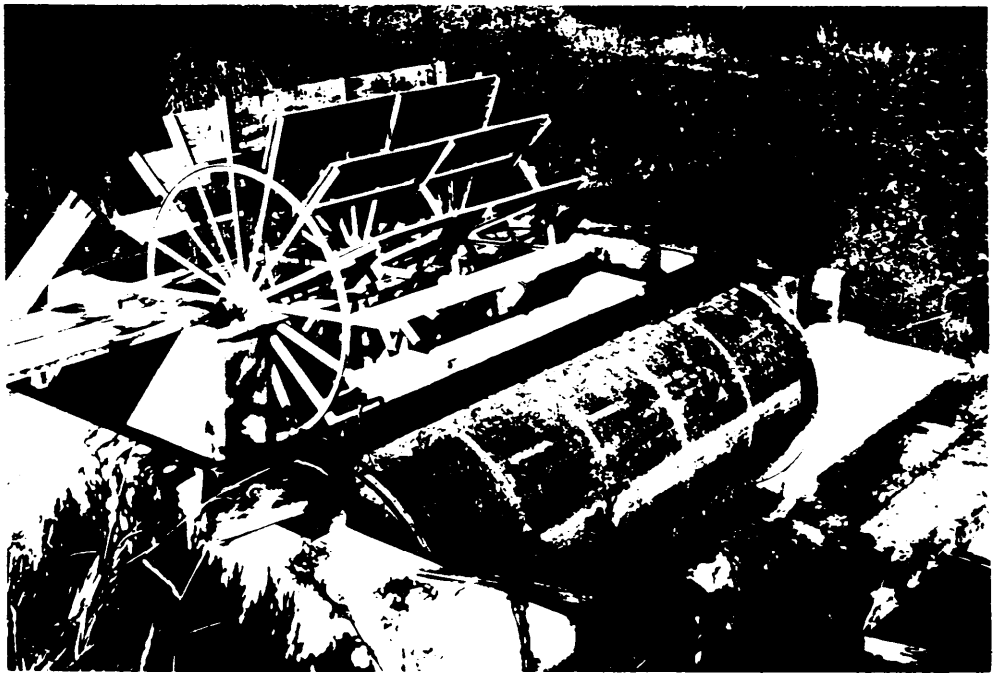


Figure 2 - Paddle wheel powered rotary drum fish screen similar to that constructed for the Pole Creek irrigation diversion.

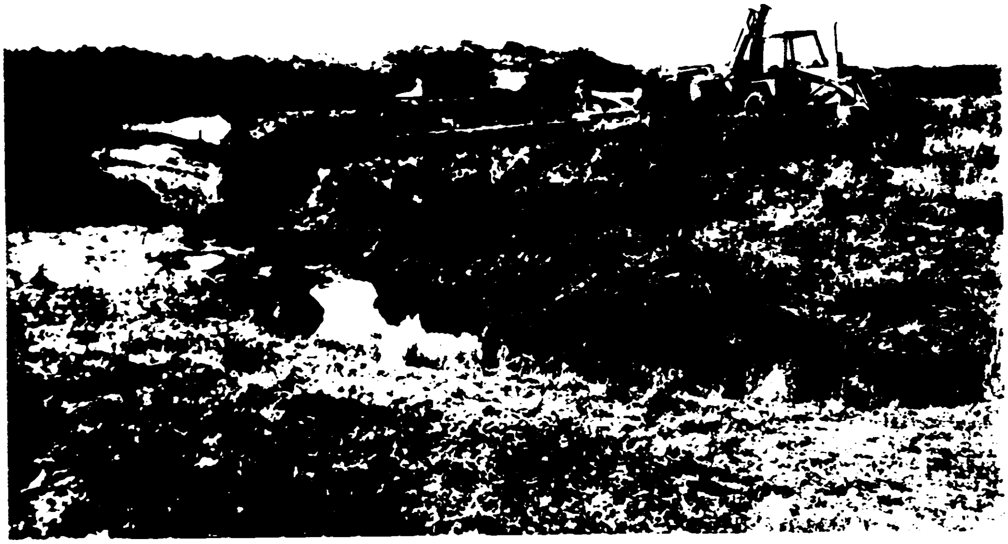


Figure 3 - Idaho Department of Fish and Game personnel and equipment complete necessary excavation for construction of the Pole Creek irrigation diversion screen.

Figure 4 - Idaho Department of Fish and Game personnel begin concrete form layout for construction of the Pole Creek irrigation diversion screen.

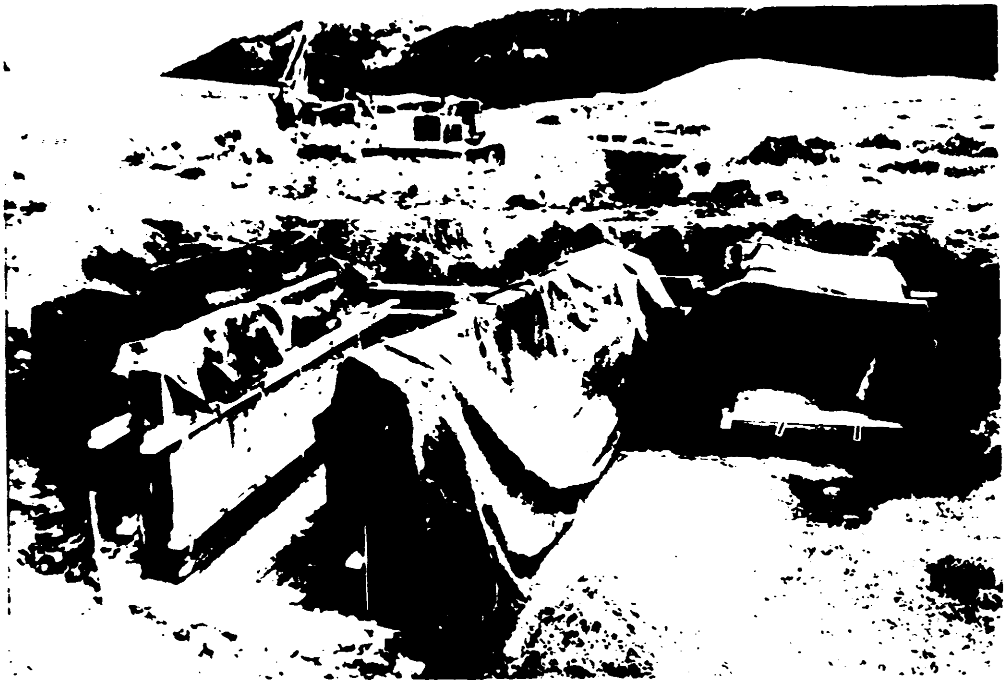


Figure 5 - The photo depicts completion of a concrete work at the Pole Creek irrigation diversion. Tarps cover the walls of the fish screen to aid cold weather curing.

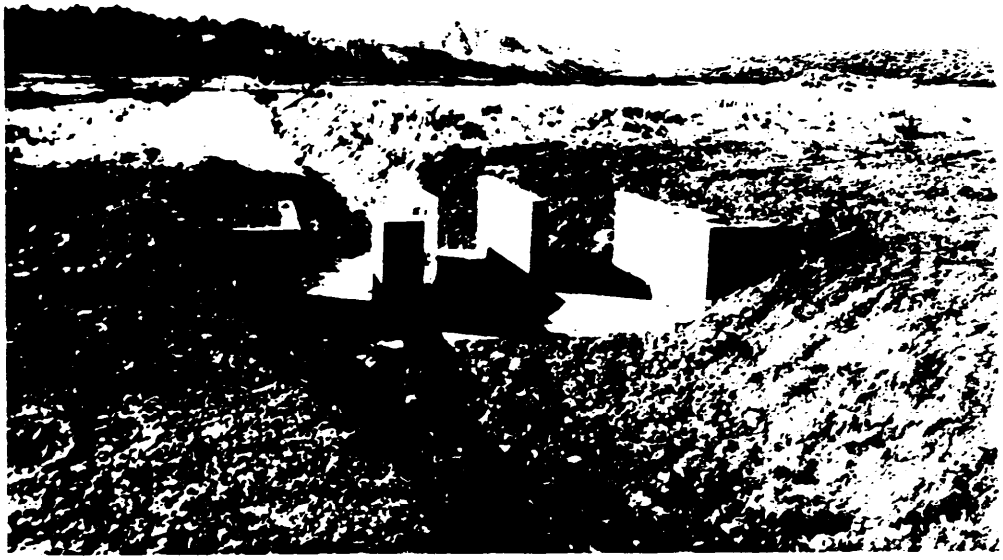


Figure 6 - The photo depicts the Pole Creek screen site following completion of the concrete and backfill work. The rotary drum screen and paddle wheel to power it will be bolted in place prior to the 1984 irrigation season.

Figures 7 and 8 - Fish screen construction at the Idaho Department of Fish and Game fabrication shop in Salmon, Idaho.

EXPECTED BENEFITS/CONCLUSIONS

Aquatic habitat surveys of Pole Creek by Forest Service biologists show that there are approximately 7.5 acres of high quality anadromous fish habitat above the irrigation diversion. On the basis of redd trend counts from similar habitats, fishery biologists with the Idaho Department of Fish and Game (IDF&G) have estimated that Pole Creek Is capable of supporting 50 chinook salmon redds and 30 steelhead trout redds per acre. IDF&G counts within the upper Salmon River basin have also shown that on the average each redd represents 2.5 escaping spawners. The habitat in Pole Creek above the diversion then is capable of supporting 937 chinook spawners and 563 steelhead spawners.

Preliminary estimates suggest that about 25 percent of the juveniles produced by these spawners may have perished in the diversion network had it not been screened. This estimate is based on the proportion of flow diverted for irrigation during the period which salmon and steelhead are rearing in and migrating down the stream (20-80%, depending upon season). Holding other survival rates constant, this loss of juveniles represents a loss of 234 chinook spawners and 141 steelhead spawners. Using National Marine Fishery Service (1982) dollar values for escaping spawners (i.e. $550/chinook and $359/steelhead) this lost production capability can be valued at $179,319 per year. Assuming a constant five year stock build up period to full production capability, and a 20 year project life, it is estimated that the screen will result in a savings of chinook and steelhead production potential worth $2,105,173 (at a 4 percent discount rate).

Bonneville Power Administration funding for construction of a rotary drum screen and fish return system on the Pole Creek diversion has led to successful achievement of the stated project objective, and will significantly contribute to Forest Service and IDF&G efforts to reestablish chinook salmon and steelhead trout runs to the stream. The benefits of the project, as detailed above, should exceed the costs by a ratio of about 70 to 1.